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Marine Engineering

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U. S. TORPEDO-BOAT DESTROYERS TRUXTUN, WHIPPLE, AND WORDEN.

The three torpedo-boat destroyers building for the U. S. Navy by the Maryland Steel Company were constructed in accordance with designs prepared by the builders, and, in general appearance and details, are entirely different from any of the others.

The accompanying plans give a very good idea of the arrangement and general design, and the dimensions will be found in the appended table. As the three boats are identical, the description of one will apply to all.

U. S. TORPEDO BOAT DESTROYER TRUXTON STARTING ON HER TRIAL TRIP.

The armament consists of two 12-pdr. r. f. guns, mounted, one on each conning tower; six 6-pdr. r. f. guns, two on each side and two on center line, and two 18-inch torpedo tubes on center line. Four torpedoes are carried, two in the tubes and two under the turtle deck forward.

The hull is divided into fourteen water-tight compartments by 'thwartship bulkheads. In addition to these, the fore-and-aft coal-bunker bulkheads divide the ship into three compartments transversely for the length of machinery space. Each bunker is divided into four compartments by water-tight bulkheads with doors. The capacity of bunkers is 185 tons.

The hull is of mild steel, with the exception of the sheer strake and stringer plate, these being of nickel steel for the length of machinery space.

The crew have quarters forward on the berth deck, with plenty of air and light. The crew's toilet and wash rooms are under the bridge deck directly above. The galley is forward of the boiler-room bulkhead, with store room and ice box underneath. Under the crew's quarters and windlass room are store rooms, awning and canvas room, ammunition, and war heads. Aft of the after boiler-room bulkhead are quarters for the firemen, with shower bath and toilet in one corner; next to these are similar compartments for the machinists and petty officers.

Entering through the after conning tower, and at the level of the berth deck, are commodious quarters for the commander on the starboard side, and for the executive officer on the port side. The officers' bath is next on the port side and commander's office on the starboard. The engineer's room is on the starboard side opposite the office. Aft of these is the ward room, extending across the ship, with pantry directly aft. The pantry stores occupy the extreme after end.

Under the petty officers', machinists', and firemen's quarters are ammunition and store rooms. The reserve

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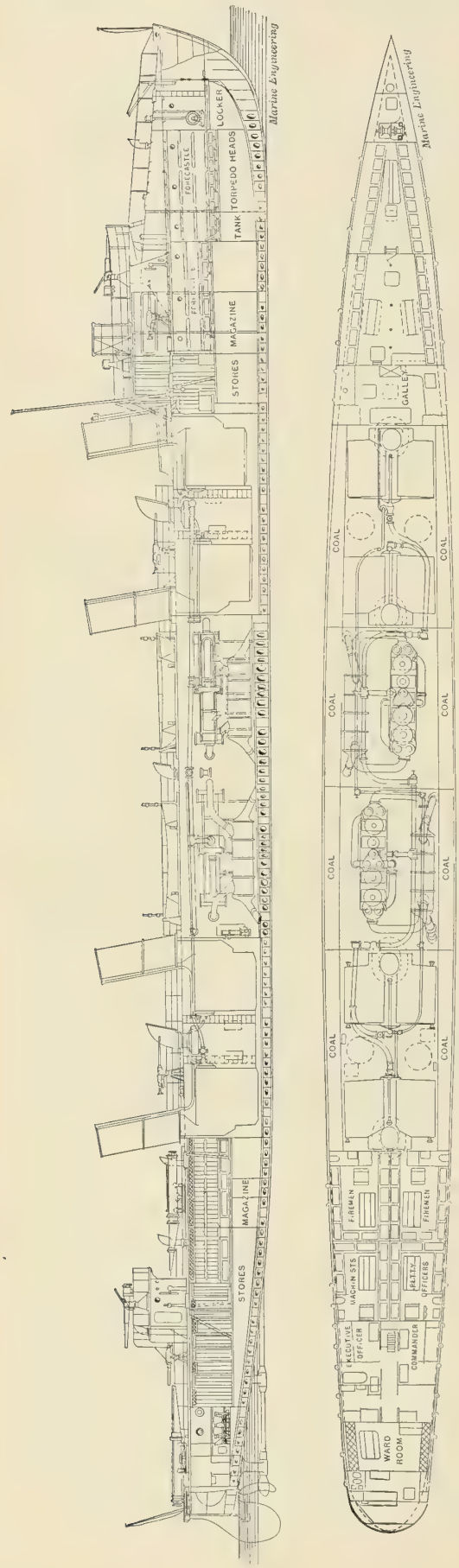


LONGITUDINAL ELEVATION AND DECK PLAN OF U. S. S. TRUXTON, WHIPPLE, AND WORDEN, BUILT BY THE MARYLAND STEEL COMPANY.

Name—Truxton.	Nationality—American.	Type—Torpedo Boat Destroyer.	
Launched—1901.	Builder—Maryland Steel Co.	Owner—U. S. Navy.	
Length over all	259 ft. 6 in.	**Engines,** number of	2
Length on 6-foot water line	248 "	Type	Four-cylinder triple
Beam, molded, 6-foot water line	22 " 6 "	Cylinder diameters	23, 34 37, 37 in.
" at deck	23 "	Stroke	22 in.
Depth, molded, at side	14 " 9 "	Valves	All piston type
Draft, loaded, 6 ft. 8½ in. forward, 6 ft. 7⅛ in. aft.		Cooling surf. (two condensers)	6,940 sq. ft.
Corresponding displacement	492 tons.	**Trial Data.**	
Block coeff.	.48	Duration of trial	One hour
Area, midship section	112 sq. ft.	Average revolutions	304
Midship section coeff.	.75	Mean speed	27.66 knots
Center of gravity on L. W. L. plane aft of center length	6.50 ft.	Average steam pressure	180 lbs.
		" air pressure	5.0 in.
Center of buoyancy above base line	4.0 "	Max. speed for one mile	29.9 knots
Center of buoyancy aft of midship section	3.65 "	Corresponding revolutions	332.8
Coal bunker capacity	185 tons	" steam pressure	235
Propellers, 3 blades number of	2	" air	6.3 in.
Material, solid manganese bronze.		**Boilers,** number of	4 Thornycroft
Diameter	8 ft. 0 in.	Total G. S.	315 sq. ft.
Pitch	11 " 3 "	" H. S.	17,768 "
Area, developed	22.7 sq. ft.	H. S. ÷ G. S.	56.4

feed tanks are located forward and aft of the boiler rooms; the capacities of each, also the arrangement and capacities of the fresh-water tanks, can be seen on the inboard profile.

The steering engine, designed by the Maryland Steel Company and built by the Bath Iron Works, is located in the forward conning tower, with rack under the main deck, and can be worked from either the forward conning tower or the bridge deck. In addition to this there is a hand gear in the after conning tower. The engine is of the vertical type with regulating valve, and, together with stand in forward tower and rack, weighs but 647 pounds, being one of the lightest engines in use for the power developed.

There are three 20-foot cutters and one 20-foot whaleboat, built to Navy Department plans, and two 18-foot Berthon boats stowed on deck. The anchors, of "Baldt" stockless type, weigh 700 pounds each, and are stowed on skids on each side of turtle deck.

The engines are of the four-cylinder, triple-expansion type, placed in separate water-tight compartments, the forward engine being on the starboard side and the after one on the port side. The sequence of cylinders is as follows: beginning forward, first low pressure, intermediate, high, and second low pressure. The cranks are at 90 degrees, the high and first low-pressure cranks being opposite, as are also the intermediate and second low pressure.

The valve gear is of Stephenson double-bar link type. All the main valves are piston valves, double-ported, there being one for each high-pressure and two for each of the intermediate and low-pressure cylinders. The crossheads work in slipper guides. The framing is of forged steel vertical columns with diagonal braces. The bed plates are composed of separate steel castings, supported upon and bolted to two channels, each having the upper flange planed down. The crank shafts are in two sections, and, together with all line and propeller shafting, have an axial hole.

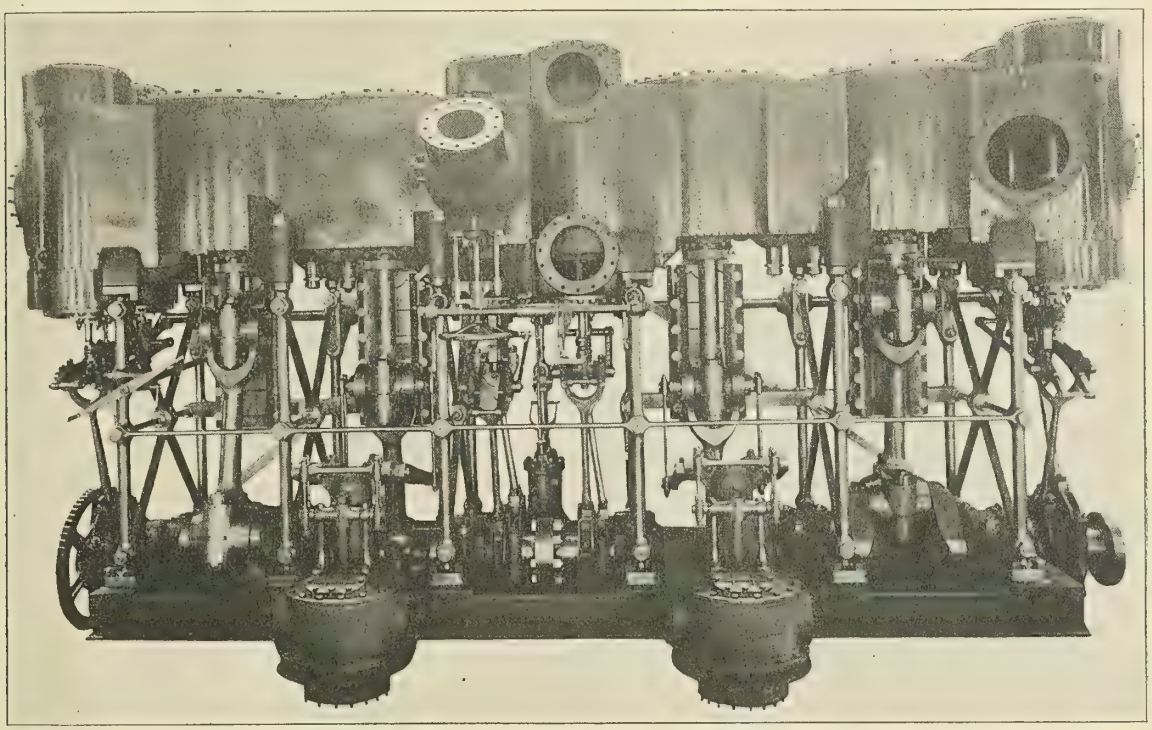
The condensers are circular, of sheet brass, each having a cooling surface of 3,470 square feet. For each propelling engine there are two double-acting vertical air pumps, driven from the high and intermediate-pressure crossheads. There is a centrifugal pump driven by a 4 1-2-inch diameter by 5-inch stroke engine on each condenser, with a connection to the 7-inch flood drain in engine and boiler compartments.

Steam is supplied by four water-tube boilers of the Thornycroft type, constructed for a working pressure of 240 pounds. Each boiler has its separate smokestack, the forward stack casing being arranged as a vent to the galley and the after one as a vent to the firemen's quarters. The four main feed pumps are of Davidson make and are located one in each engine room.

On June 25 the *Truxtun* left Pearson's wharf at 11.30 A.M. to undergo standardizing trials over the Government course off Barren island, and, after receiving the Trial Board off the mouth of the Pawtuxet, she immediately entered upon the test. In all, ten runs were made over the measured nautical mile, five runs south and five runs north. The tide was running south and there was a strong N.N.E. wind, making the sea quite rough. As can be seen from the accompanying table, the runs were very satisfactory and all the machinery worked smoothly, without undue heating or noise.

A noticeable feature was the steadiness and absence from vibration, especially at the highest speed. In turning at the ends of the course a very pretty effect was noticed. On account of the rudder being overhung, the flow of the water against the surface when at about 15 to 20 degrees helm angle caused a miniature fountain. At the highest speed the water was thrown about 8 feet above the level of the deck.

The slipping of the catch on the after fire-room hatches caused the speed for the ninth run to fall below where it would have been, but on the next run (against the tide) a speed of 29.8 knots was obtained, which, with tidal corrections, gave a true speed of 29.9 knots.



FRONT VIEW OF ONE OF THE FOUR-CYLINDER TRIPLE-EXPANSION ENGINES FOR THE DESTROYERS.

On Thursday, the 26th, after receiving the Trial Board at Pearson's wharf, the *Truxtun* started on the one-hour's run, going north for 30 minutes and south for 30 minutes.

The weather conditions were similar to those on the previous day, causing a very heavy sea. From the curves of standardization trials it was only necessary, to fulfill the contract requirements of 26 knots, to hold 153 pounds of steam, which would give 283.8 revolutions. For over an hour an average of 304 revolutions was obtained, giving a mean speed of 27.66 knots.

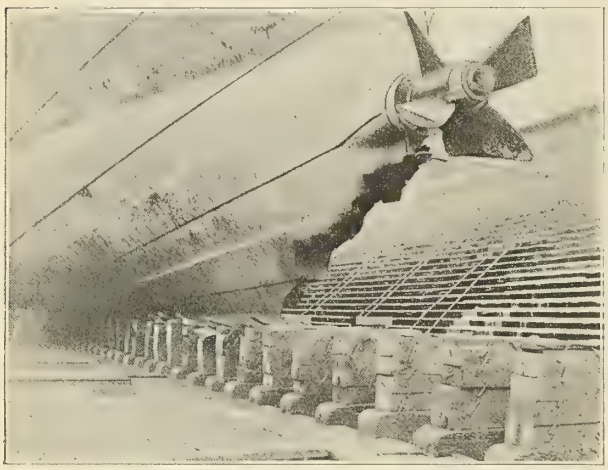
After manœuvering the vessel to test steering gear and inspection of all compartments, the Trial Board left for the *Gloucester*, and the *Truxtun* departed for Sparrow's Point to receive the finishing touches preparatory to being turned over to the Government. As this was only the fourth time the *Truxtun* had been away from

the wharf for trial runs (three being builders' trials), the results obtained are highly commendable, and, we believe, establish a record for torpedo-boat destroyers in this country.

Since writing the foregoing the *Whipple,* a sister ship to the *Truxtun,* has attained a speed on official trial of 30 1-4 knots, and on the one-hour's run averaged 27.46 knots, thus beating the *Truxtun's* record.

Steamer Hero.

The Norwegian steamer *Hero,* after being driven ashore and badly damaged, was taken by the wreckers to the dock of the Baltimore Shipbuilding and Dry Dock Company, when an examination was made which revealed very serious damages to the stern and bottom throughout, as shown in the accompanying engraving. About 200 plates had to be renewed on the bottom; the stern frame was completely demolished, and three of the blades of the propeller broken off short; a new stern frame was fitted, also rudder and the wheel. A



DAMAGED STERN OF THE NORWEGIAN STEAMER HERO.

large section of the keel had to be renewed, and the main engine and auxiliaries were dismantled. A new low-pressure cylinder had to be made, and the entire line shafting and bearings were trued up. The repairs to the upper works of the hull included entire new joiner work, new pilot house and chart room, and a main deck of Georgia pine from end to end. The winches and deck beams had to be thoroughly overhauled, and all the rigging stripped and renewed. The entire vessel, inside and out, was scaled and painted. New anchors and chains were furnished, sails were renewed, and she was equipped with new lifeboats, and, in fact, all equipment had to be renewed, so that the vessel will leave the yard equal to, in most respects, a new ship. Her dimensions are: 322 feet 3 inches long, 40 feet beam, 29 feet 6 inches deep. She was built at Sunderland, England, in 1881, and is propelled by a compound engine with cylinders 21 and 55 inches in diameter by 45 inches stroke.

STABILITY OF AN OIL-TANK STEAMER.

BY P. F. WALKER.

The effect of oil or other liquid in a ship, when the containing tanks or compartments are not completely filled, is to reduce the statical stability. This is due to the fact that as the ship inclines to one side the liquid within moves in the same direction, thus causing the center of gravity of the entire ship to be shifted horizontally toward the new position of the center of buoyancy, and so reducing the length of the moment arm of the righting couple. Looking more closely at the forms of the spaces occupied by the moving liquid, first with the ship upright and then in the inclined position, it is seen that the change has been produced by emptying the wedge-shaped space between the original and the final surfaces of the liquid on the upper side of the ship, and filling the corresponding space on the opposite side, and consequently that the change in the position of the center of gravity is due wholly to the transference of the liquid from one of these wedge-shaped spaces to the other, the two being necessarily equal in volume. It follows, therefore, that the amount of liquid present in the vessel, in addition to that necessary to fill the wedges, is immaterial so long as small angles of heel are considered, the total weight of the ship being constant and all other weights fixed. For large angles of heel the shape and size of the wedges will depend on the depth of the tanks, and hence the amount of liquid present will then have an indirect effect.

In dealing with the question of stability there are two points to be considered: First, the conditions affecting the steadiness of the ship in the upright position; and, second, those influencing the tendency of the ship to right herself after being inclined through large angles.

Steadiness in the upright position is indicated by the value of the equation for the stability moment for an angle of heel indefinitely small. This equation may be written in the form:

$$dM = D \times GM \text{ sin. } d\theta,$$

where dM = stability moment,
D = displacement in tons,
GM = metacentric height in feet,
$d\theta$ = the indefinitely small angle.

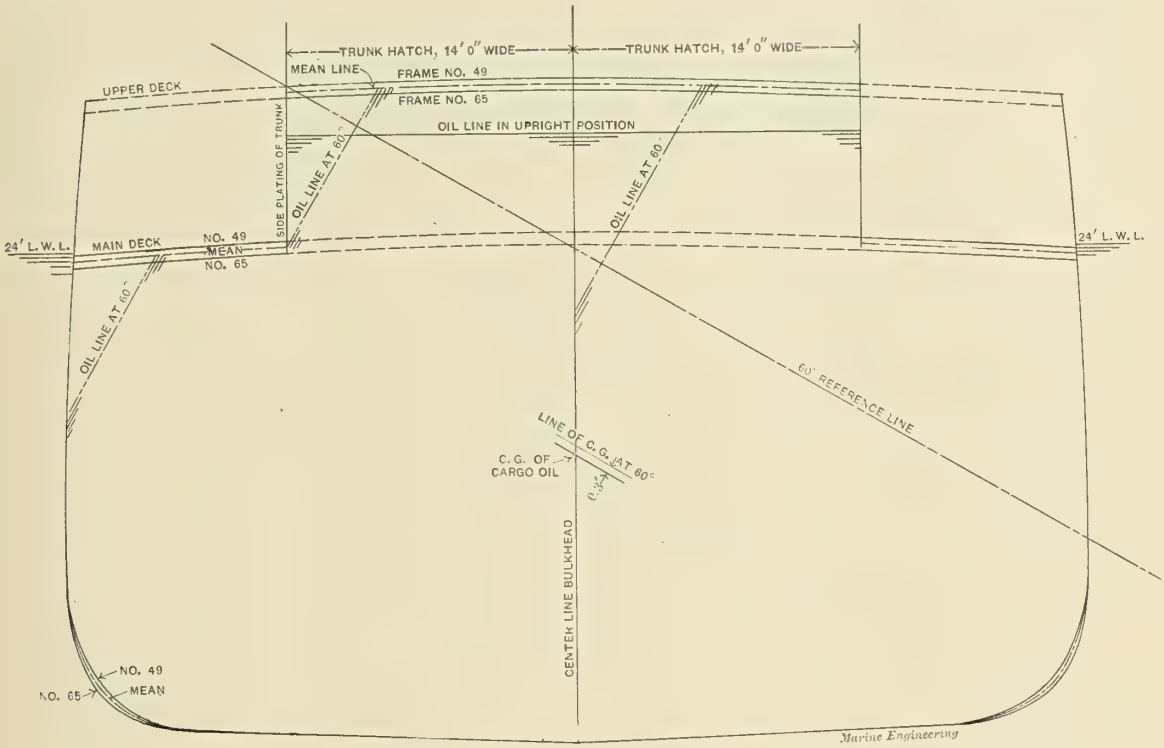
The product $D \times GM$ gives the relation between the stability moment at an indefinitely small angle and the angle itself, and therefore is a measure of the rapidity of increase in stability as the vessel starts to heel; or, in other words, it gives the direction of the curve of statical stability at the origin. For a given displacement this value is seen to depend directly on the metacentric height, and so it has been found convenient to express the influence of a free liquid surface in the ship in terms of its virtual effect on this quantity. It is shown in all standard works on Theoretical Naval Architecture that the effect of the horizontal shift of the center of gravity of a liquid, due to a small angle of heel, is the same as would be produced by raising the same weight vertically through a height equal to the moment of inertia of the free surface divided by the total volume of liquid, the center of gravity of the entire ship being thus raised in the inverse ratio of weight of liquid to weight of ship, and the virtual metacentric height correspondingly reduced.

At large angles of heel the value of the stability moment will be influenced by the value of the metacentric height for the upright position, but also by the amount of freeboard possessed by the ship as well as by certain features of form. Direct calculation, therefore, becomes necessary, both for determining the stability arm in the usual manner and the horizontal shift of the center of gravity of the free liquid. It is with this phase of the subject that the present article is intended to deal, such calculations having been made by the writer for a ship designed to carry oil in bulk and now in process of construction at one of the Atlantic coast yards.

the cargo compartments is 6,710 tons of oil at 57.22 pounds per cubic foot. With all fuel tanks filled, however, only 6,390 tons of cargo oil can be carried at 24 feet draft, and it is for this condition that the present calculation is made, the oil level in the trunks being 2 feet 3 inches below the mean level of the upper deck beams.

CALCULATION OF STABILITY FOR THE SHIP WITH FIXED CENTER OF GRAVITY.

This was done with an integrator in the usual manner. The position of the center of gravity was determined from estimated weights and leverages, a metacentric height of 4 feet 3 inches being taken, although



SECTION IN TANK NO. 2, OIL TANK STEAMER

The ship is an oil-tank steamer of the ordinary type and of the following dimensions:

Length, B. P.	374	ft.	0 in.
Length over all	399	"	0 "
Breadth, molded	49	"	11½"
Depth at mid-length	30	"	3 "
Designed load draft	24	"	0 "
Displacement	10,391	tons.	

The oil-tank space begins about 73 feet aft of the stem and extends aft 208 feet 4 inches, 12 1-2 feet at the after end being used for fuel oil. The machinery is aft, additional fuel-oil tanks being fitted alongside of the boilers. In way of the midship tanks fore-and-aft bulkheads are fitted through the 'tween deck space, 14 feet out from the center line, as shown in the section plan, thus forming trunks 7 feet 6 inches deep. A continuous center-line bulkhead to the upper deck extends throughout the oil space, while transverse oil-tight bulkheads divide the space into six double compartments for cargo oil and one for fuel oil. The total capacity of

in ordinary conditions the value would probably be somewhat more. The integrator was placed in such positions at the several angles of inclination that the axis of moments for the instrument passed through the center of gravity. Dividing the summation of moment readings by the summation of area readings would thus give immediately the value of the stability arm, provided the water lines cutting off the true load displacement in the several angular positions were available. To avoid the difficulty of determining these true water lines, readings were taken at each angle for three water lines, 4 feet apart, and so placed that the true water line would fall within their limits. The results were then plotted on abscissa values representing displacement, a curve being drawn for each angle, giving portions of what would correspond to cross curves of stability. The values obtained from these curves for the load displacement, plotted on an abscissa scale of angles of inclination, gave the curve for fixed center of gravity shown in the accompanying cut.

EFFECT OF THE FREE-OIL SURFACE.

The virtual metacentric height was first determined. As before stated, the difference between this and the actual *GM* is obtained by dividing the moment of inertia of the free surface by the volume of the liquid, and then multiplying by the ratio of weight of liquid to displacement, or weight, of the ship. Since the moment of inertia of area varies as the third power of the breadth of surface, it is seen that the introduction of the center-line bulkhead and the trunks, so dividing the oil surface into two portions, each approximately one-fourth the total breadth of the vessel, reduces this quantity to approximately one-thirty-second of what its value would be for the complete, unbroken surface. In the fuel-oil space, however, the level was assumed to be below the main deck, since this condition must be reached during a voyage. Completing the calculation on this basis, a reduction of 0.35 foot in the metacentric height was found, making its virtual amount 3.9 feet.

The horizontal shift of the oil at successive angles of heel was determined in much the same manner as was the stability arm in the fundamental calculation. As the oil level in the different tanks would differ, due to the rise of sheer forward, the tanks were taken separately. By drawing in mean deck lines and mean lines at the bilges in the two forward tanks, the other tanks being within the parallel mid-body of the vessel, only one reading from the integrator for each tank was necessary. In this part of the work the true oil line for each tank and at each angle was determined, as is shown in the section plan for tank No. 2 at 60 degrees, the ship being inclined to starboard. The line for the starboard half of the tank was readily determined by making the triangular-shaped section above the oil line equal to the nearly rectangular section above the line for the upright position. On the port side, however, it is seen that as the vessel inclines, as soon as the triangular section cuts below the bottom of the trunk the air imprisoned above will begin to pass below the main deck plating, continuing as the angle increases, until the oil rising in the trunk cuts off further passage. The final oil level will, therefore, be as shown in the plan. These lines may be drawn in on the regular body plan, but it is desirable that a special plan be made to avoid confusion. This being done, the integrator readings were taken, with the moment axis of the instrument passing through the center of gravity of the oil in the upright position, the shift of the oil center being thus directly found. The shift of the center of gravity of the entire ship bears the same relation to this result as does the weight of oil to the weight of the ship.

The dash-dot line on the curve sheet shows the result of this calculation for angles up to 90 degrees. The ordinates of this curve, subtracted from those of the curve first determined, give ordinates for the true stability curve for the stated conditions.

In connection with the above calculations an investigation was also made to determine the effect of bilging two oil compartments on one side of the ship. Such condition might be produced by injury to the shell plating near one of the transverse oil bulkheads. Only the statical effects were considered, and for inclinations in the transverse direction only. The same conditions would be fulfilled by assuming that the breach in the enveloping shell was of sufficient size to allow the water to pass in and out without restraint as the vessel rolled among waves. It is evident that this would be the most dangerous condition.

After bilging, the oil would pass out of the vessel until its level fell to such a point above the breach that the head of water outside and of oil within became of equal effect. This would be true when those heads were in the inverse ratio of the densities of the two liquids, that is, 57.22 to 64 for salt water. The oil within, assuming that no interchange of position occurred, would then be supported by the water pressure from without, and the weight of oil originally in the affected compartments would thus be removed from the ship. Correspondingly, the ship would lose buoyancy to the amount of the volume of the same compartments up to the original load water line. The ship would, therefore, rise or sink in the water, according as the weight of oil removed were greater or less than the buoyancy lost, the change in draft, if the ship be assumed to remain upright, being equal to the difference between these two quantities expressed in tons, divided by the tons per inch of immersion for the water plane as reduced by the area through the injured section. If the center of the injured compartments, measured in the fore-and-aft direction, be at the center of gravity of the original load water plane, no change of trim would occur. Otherwise the change of trim could be readily determined and any necessary corrections made in the stability calculations. Such corrections would not, however, usually be considered necessary for the changes of trim possible under the given conditions.

For the ship under consideration it was found that the lost weight exceeded the lost buoyancy, and consequently that the ship would rise in the water. This would increase the freeboard and hence the stability at large angles, other values remaining constant. The ill effects of a reduced reserve buoyancy—that is, of buoyancy above the water line—would here be lessened because of the initial list which the ship must take away from the affected side. Therefore it seemed that the metacentric height was the only factor to be investigated, provided its value should not be found to be materially reduced.

To do this the results of four changes were to be considered.

First. Due to the rise of the vessel in the water, the center of buoyancy, relative to the center of gravity of the ship, would be lowered, thus lowering the metacenter. This would, however, be opposed by the fact that the center of gravity of the lost buoyancy was relatively low.

Second. The moment of inertia of the water plane would be reduced, thus lowering the metacenter by shortening the metacentric radius.

Third. The volume of displacement would be reduced, thus raising the metacenter by lengthening the metacentric radius.

Fourth. The center of gravity of the ship would be raised or lowered according as the center of the weight of oil removed were below or above the original center of the ship.

Of these changes, the effect of the first and fourth was found to be inappreciable. As between the second

and third, the latter was found to be of greater moment, and consequently the net result was an increased metacentric height.

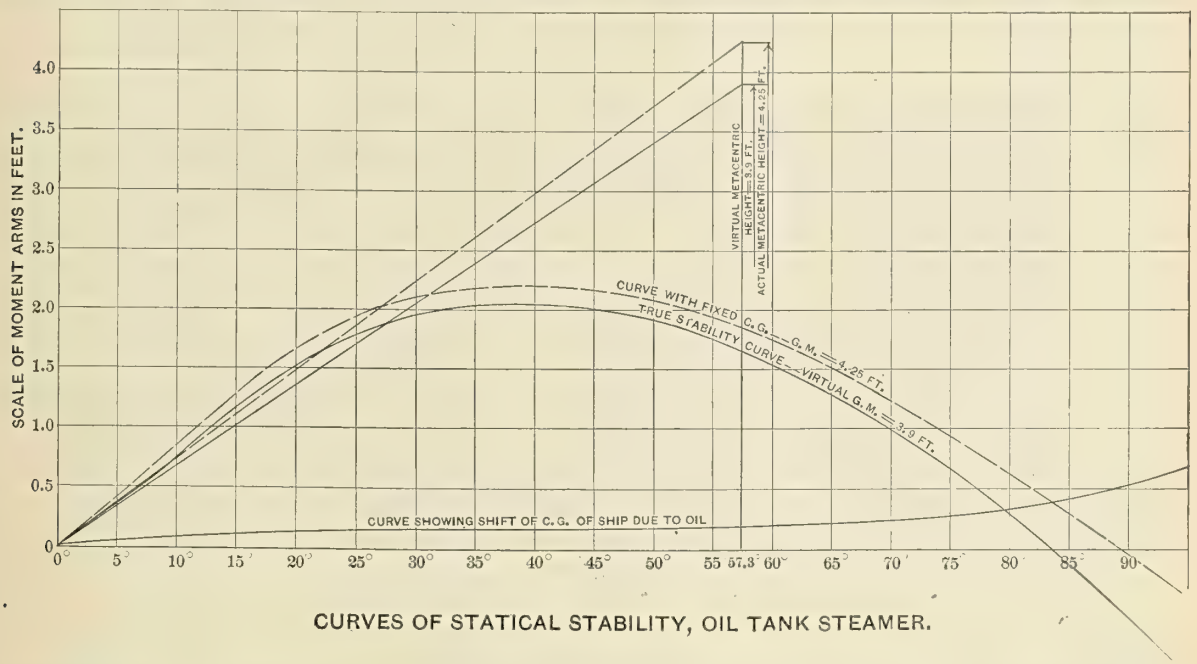
The amount of the permanent list that would be given the vessel is readily determined in an approximate manner. Writing again the equation for stability moment for a small angle, making that angle equal one degree and putting the sine of the angle equal to its circular measure, as is very nearly true, we have:

$$M = D \times GM \times 0.01745,$$

where M = moment to heel the ship one degree.

The total moment tending to heel the ship is found by multiplying the difference between the lost weight and lost buoyancy by the distance of its center of gravity out from the center line. This quantity being divided by the value of M, found above, gives a first approximation to the number of degrees of heel. If the angle so found be small it may be sufficiently correct to satisfy practical considerations. If large, the new metacentric height and the new value of M in this inclined position should be calculated and the first result corrected for a mean value of M. Following through this process for the case in hand gave an angle of heel of about 7 1-2 degrees.

From the above series of investigations it is evident that with the metacentric height assigned ample stability is assured for oil steamers of this class. Trunks of greater width could not be adopted with safety, however, nor could the oil level be much lower in the trunks without greatly increasing the effects of free surface after a moderate angle of inclination had been reached. This is shown by the marked rise in the curve showing effects of free surface, beyond the angle where the oil level in the port tank cuts under the main deck plating. With a lower oil line this rise would begin much earlier. The effects of bilging compartments are evidently much less serious than with vessels carrying solid cargoes.


SCALE OF MOMENT ARMS IN FEET.
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
0° 5° 10° 15° 20° 25° 30° 35° 40° 45° 50° 55 57.3° 60° 65° 70° 75° 80° 85° 90°
VIRTUAL METACENTRIC HEIGHT = 3.9 FT.
ACTUAL METACENTRIC HEIGHT = 4.25 FT.
CURVE WITH FIXED C.G. — G.M. = 4.25 FT.
TRUE STABILITY CURVE — VIRTUAL G.M. = 3.9 FT.
CURVE SHOWING SHIFT OF C.G. OF SHIP DUE TO OIL

CURVES OF STATICAL STABILITY, OIL TANK STEAMER.

School of Naval Architecture at Cooper Union.

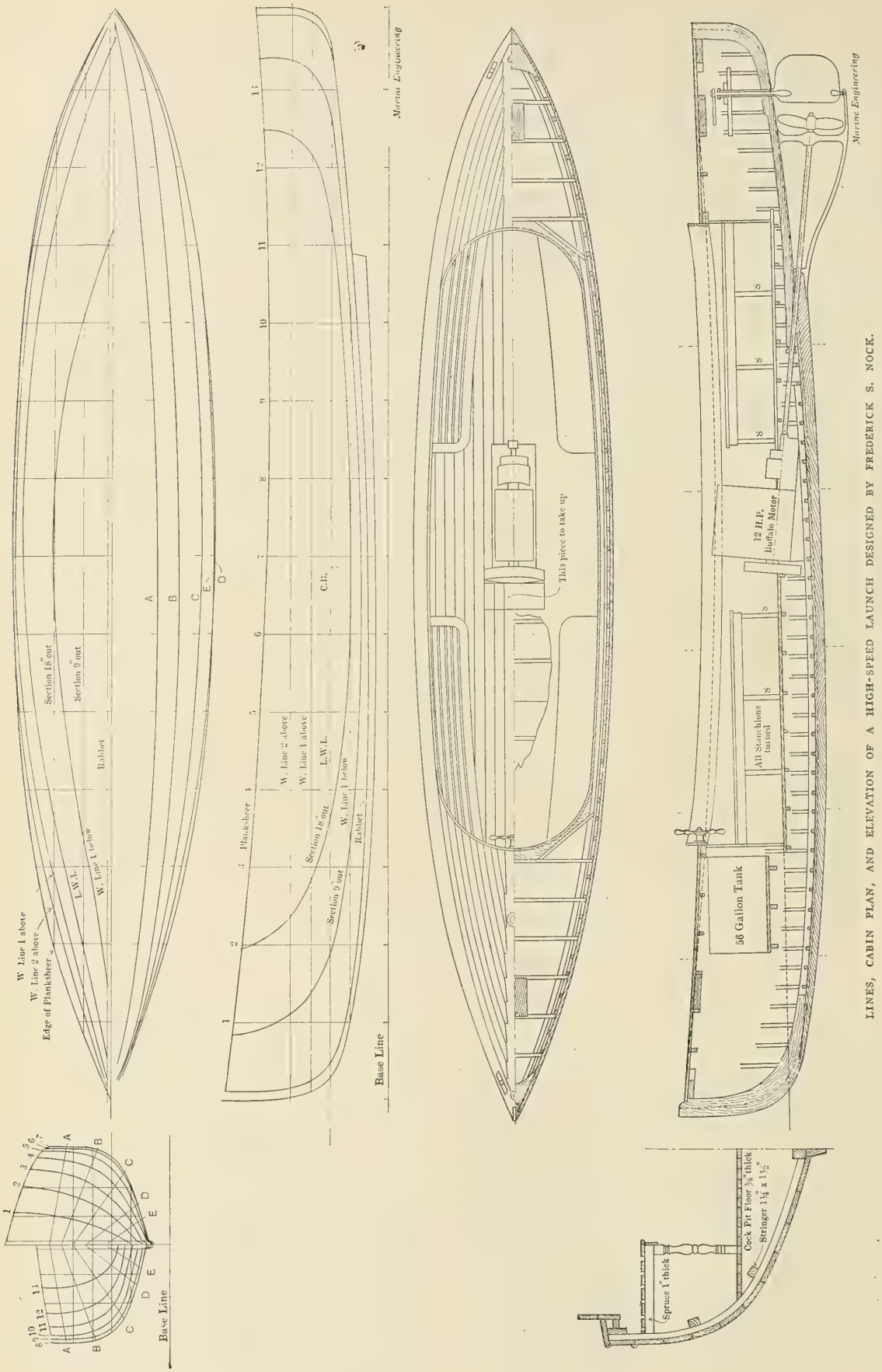
We are glad to learn that the trustees of the Cooper Union for the Advancement of Science and Art have added Naval Architecture to their night school curriculum, and have engaged the services of Prof. Alex. J. Maclean, of the Webb Academy, as its first instructor. This class was organized on Monday evening, September 22, and will be continued each Monday during the winter and spring months. Applicants can be registered at the office of the director at Cooper Union, and they should have some knowledge of elementary algebra and geometry; but these subjects, together with elementary trigonometry, can be acquired during the first year by attending the Night School of Science.

A similar school was started four years ago at the Franklin Institute, Philadelphia, by Prof. Maclean, and has met with marked success, many of the graduates having secured lucrative positions in the government service and in private yards.

Understanding the great value of this instruction to their employees, the Messrs. Cramp and Sons sent their apprentices to this class, paying their fees and giving special prizes to the most successful ones. Messrs. C. H. Cramp, H. W. Morse, Clement A. Griscom, and Lewis Nixon gave valuable prizes each year for the successful students in this class.

Since there are no fees charged at the Cooper Union, a larger attendance than that at the Franklin Institute will doubtless follow. Special prizes will be given by interested firms in the city. This class should obtain its students not only from the employees of the different shipbuilding and repairing yards in and about New York city, but also from shipowners, yacht and ship brokers, and maritime lawyers' offices.

The course of instruction embraces theoretical naval architecture, and ship construction and design. These two branches are subdivided under various heads, and will be presented in the form of lectures.



LINES, CABIN PLAN, AND ELEVATION OF A HIGH-SPEED LAUNCH DESIGNED BY FREDERICK S. NOCK.

High-Speed Launch.

The speed launch shown in the accompanying plans is one of three built last spring from the designs by Frederic S. Nock, of West Mystic, Conn.

The dimensions are: Length over all, 28 feet; length on the water line, 26 feet 6 inches; breadth, extreme, 5 feet; draft to rabbet, 11 1-2 inches; draft to the bottom of the skeg, 2 feet.

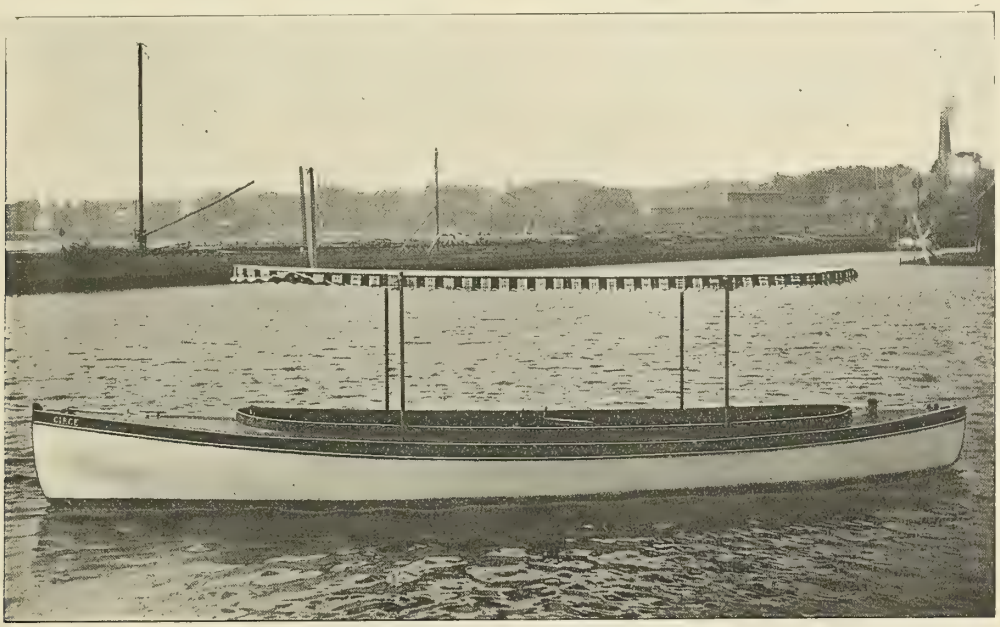
These craft are very strong and light, and, though designed for speed, the owners did not care to sacrifice every comfort in order to attain as much speed as was possible in a boat of this size.

The keel is of white oak, sided 3 inches and molded about 4 inches; the frames of white oak, steam bent, are 1 inch square and spaced 6 inches on centers; where it was possible they were in one piece from sheer to sheer, crossing the top of the keel, and strong bent oak floors secured the lower ends of them to the keel, and a heavy oak keelson was mortised over the frames and floors and securely bolted to the keel. A yellow-pine clamp, 7-8 inch by 3 1-2 inches, securely fastens the heads of the frames and sheer strake, and to further strengthen the framework a couple of bilge stringers of yellow pine, respectively 1 1-4 and 1 1-2 inches square, were secured to each side. Clear white cedar 3-4 inch in thickness was used for the planking, same being put on in narrow strips and secured to the frames with brass screws, the heads of which are sunk and the holes filled with wood plugs. The entire interior is finished in mahogany.

The seats are made with slatted tops, and this was done so as to keep the weight down as much as possible. The beams for the cockpit floor are fastened to the frames on each side of the boat, and the floor boards of white pine are fastened down with screws to admit of their removal at any time. The deck, of clear white pine, was laid in narrow strips sprung with the plankshear and nibbed into the king plank, the seams being calked with yacht cotton and finished flush. The fore-and-aft logs for the engine bed are 6 feet long and extend from the foreside of the engine aft to the shaft log, being mortised over the frames and fitted tight to the planking, with fastenings through frames and planking. The athwartship pieces are mortised into the logs and bolted through and through, making a very strong bed.

Gasoline is carried in a tank at the after end of the forward deck, the tank having a capacity of about 56 gallons, or one barrel, and so arranged with partitions as to prevent the liquid from swashing around when the boat is in a seaway.

The motor, which is one of the latest types of high-speed gasoline engines manufactured in the States, is by the Buffalo Gasoline Motor Company, and rated by them as 14 H. P. They are light, compact, and strong, and can be run from 200 to 1,000 revolutions per minute, at the latter speed developing more than their rated power.



TWENTY-EIGHT-FOOT HIGH-SPEED LAUNCH.

The arrangement for the ignition of these motors is original with the builder, as also the method of changing the spark from early to late, or *vice versa,* it being controlled by a small lever under the control of the operator at all times. The four cylinders are cast in one piece, the same being set on the base and made rigid by six round steel rods. The two center cranks are set opposite to the two end ones, and the ignition occurs at such times as to reduce the vibration to a minimum. The crank chamber is arranged with aluminum doors at each side to admit of access to the interior. The lubrication of the cranks, etc., is well arranged, the lower part of the base being filled to a certain limit with oil into which the cranks splash. This supply of oil is constantly kept up by the overflow from the oil cups which lubricate the pistons, and any excess above a certain point flows to a tank.

The propeller is three-bladed, 20 inches in diameter, 30 inches pitch, and at 600 to 650 revolutions per minute has developed over 12 1-2 miles per hour.

SURFACE CONDENSERS.

BY C. C. ROBBINS.

An article on steam condensers, recently appearing in the technical press, presents again Mr. J. M. Whitham's formula for proportioning the cooling surface of surface condensers. Some years ago Mr. Whitham developed this formula from the data of tests made on the U. S. S. *Dallas*, and it was put forth at the time as giving practically correct results only for conditions similar to those under which the data were obtained, and as being decidedly superior to the various "rules of thumb" then in vogue. The formula is as follows:

$$\text{Sq. ft. of surface} = \frac{W \times L}{U \times (T - t)}, \text{ in which}$$

W=pounds of steam condensed per hour.

L=latent heat of steam at condenser pressure.

U=heat units transferred per sq. ft. per hour for each degree of difference between steam and water temperatures.

T=temperature of steam at condenser pressure.

t=average temperature of cooling water,

= half the sum of the entering and leaving temperatures.

The values of L and T are obtained from any table of properties of steam, and U is taken as 180 and 210 for brass and copper tubes, respectively. It was based, as all such formulas are, on the transmission of a certain number of heat units per hour per square foot of surface for each degree of difference between the steam temperature and the average temperature of the cooling water.

Thus the numerator $W \times L$ evidently represents the total heat units to be taken from the steam, since steam gives up in condensing practically only its latent heat. And the denominator $U \times (T - t)$ plainly represents the heat transmitted by one square foot of surface.

This formula, while practically correct for ordinary condenser conditions, contains one or more assumptions which seriously affect its accuracy over a wide range of temperatures, such as are found in feed-water heaters and other apparatus in which heat is transferred from steam to water through thin metal partitions. Unfortunately, lack of knowledge of this fact has led to its application to cases for which it was never intended, and the results have not always been satisfactory.

The most serious error lies in assuming the average temperature of the water to be its arithmetical mean, or half the sum of the initial and final temperatures. This is not strictly correct. When the water first enters the tubes the difference in temperature between it and the steam is great and the water takes up heat rapidly, reaching its assumed average long before leaving the condenser. But as the final water temperature is always much below that of the steam, it continues to absorb heat as long as it is in the condenser, and its true average temperature is much higher than the assumed average. This decreases the amount of difference and consequently the heat transmitted per square foot of surface. This fact led to the derivation, by Mr. C. P. Poole, of a formula giving the correct average temperature of the water and therefore applicable to all ranges of temperatures. This formula, which involves the use of hyperbolic logarithms, is rather formidable in appearance, but is very simple in application. Arranged for condensers, it is as follows:

$$\text{Sq. ft. of surface} = \left(\frac{H - h}{F - I} \times \text{hyp. log.} \frac{S - I}{S - F} \times W\right) \div U,$$

in which

H=heat units in one pound of steam at condenser pressure.

h=heat units above 32° in one pound of condensed steam.

S=temperature of steam at condenser pressure.

F=final temperature of cooling water.

I=initial temperature of cooling water.

U=heat units transferred per hour per sq. ft. per degree of difference, as before.

W=pounds of steam condensed per hour.

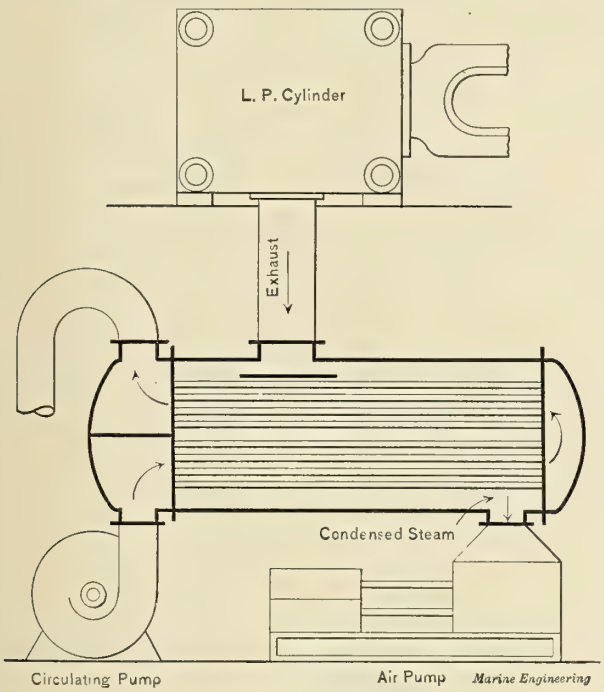
This formula takes cognizance of the fact, ignored by Mr. Whitham's formula, that the temperature of the condensed steam is always lower than that due to the pressure in the condenser; in other words, that more than the latent heat is abstracted from the steam. An inspection of the cut will show this. The presence of air in the condenser will keep up the absolute pressure, but the steam, after condensing upon the upper tubes, has to pass over the remaining lower tubes before it reaches the outlet. These tubes are much cooler than the upper ones, since they receive the coldest water, and they will continue to abstract heat from the steam after it is condensed. There is very little available data concerning the exact temperature of the condensed steam in practice, but it is probably safe to assume that it is about ten degrees lower than the steam or vacuum temperature.

To make an article of this kind of any value in proportioning new condensers or in checking up proposed designs, it is necessary to give not only the formula and the approximate values of the various factors, but to show how these values are obtained and what are their limits. In this formula, the total heat, H, in one pound of steam is taken by some engineers as the heat in a pound of steam at the condenser pressure. Other engineers claim that it should be taken as the heat of steam at the terminal pressure at which it is discharged from the engine cylinder. This terminal pressure is always much higher than that in the condenser, and the steam of course contains more heat. The difference, however, is very slight, steam at 25 inches vacuum containing 1,120 heat units per pound, and at 10 pounds gage pressure, 1,155 heat units. It is safe, then, to assume the value of H in the formula as 1,150 for all degrees of vacuum; the difference will not appreciably affect the amount of surface, and the number is easily remembered.

The maximum final temperature, F, of the cooling water evidently depends largely upon the temperature of the engine exhaust. In the usual form of condenser the hottest water passes through the upper tubes, where it meets the hottest steam; and in order that condensation may readily take place, it is necessary that the temperature of the leaving water be considerably below that of the entering steam. Again, even if it were desirable, it is impossible in the best designed condensers to raise the temperature of

the water to that of the steam, since only a part of the water can be brought into contact with the hot tube surface. Some of the water must escape without touching the cooling surface. This maximum water temperature, F, can very properly be taken at 15 to 18 degrees below that of the steam, say 16 degrees. If it is allowed to approach much nearer to that of the steam, an abnormal amount of surface will be required. If more water is circulated and the final temperature lowered, the cooling surface will become more efficient because of the greater difference between the steam and average water temperatures.

The allowable working value of the initial water temperature, I, plainly depends upon the locality and the source of supply. Even in temperate climates, where the supply is obtained from a large body of water, it is proper to assume a temperature of not



ARRANGEMENT OF CONDENSER.

less than 60 to 65 degrees, as the water will reach this point at some period of the year. In tropical climates, and in cases where the water is obtained from a shallow pond, this temperature may easily reach 80 degrees in summer. When a cooling tower is installed and the circulating water is used continuously, the initial temperature is usually about 80 degrees.

The value of U depends largely upon the condition of the cooling surface as regards its freedom from grease and scale; upon the velocity with which the water is passed over the surface, and the proportion of the entire body of water which actually comes into contact with the surface, etc. With a properly designed condenser, the velocity of the water and the motion imparted to it to bring as much of it as possible into contact with the tubes, can be made such as to allow a value of U=300 with reasonably clean tubes. If a considerable coating of grease is necessarily allowed to accumulate on the tubes, as in very long voyages, it is probable that a value of U=200 to 250 is all that may be safely allowed. Again, in some instances—namely, water-works pumping engines—steam-tube condensers are employed, in which the steam passes through the tubes. Here the value of U is comparatively very low because of the enforced low velocity of the water and the large portion of it which must escape without reaching the hot surfaces. In such cases the values in the following table must be modified in proportion to the assumed value of U.

We have now data enough to work out a numerical example, requiring only to settle the vacuum desired and to decide the initial water temperature. Let it be required to find the cooling surface to condense 10 pounds of steam per hour, producing a vacuum of 26 inches with cooling water at a temperature of 70 degrees.

The steam temperature, S,	=	125°
The value of H (assumed)	=	1150
The " " $h = 125 - (32 + 10)$	=	83
The " " $F = 125 - 16$	=	109
The " " I (assumed)	=	70
The " " U	=	300

Then

$$\text{Sq. ft. of surface} = \left(\frac{1150-83}{109-70} \times \text{hyp. log.} \frac{125-70}{125-109} \times 10\right) \div 300$$
$$= (27.4 \times \text{hyp. log. } 3.44 \times 10) \div 300$$
$$= 1.13 \text{ sq. ft.}$$

The accompanying table is worked out upon these assumptions, and gives the square feet of cooling surface and the pounds of circulating water required to condense 10 pounds of steam per hour. The upper number in each square gives the surface according to Whitham's formula, assuming copper tubes; the second number, the surface according to Poole's formula; and the third, the pounds of cooling water. It appears that the results of the Poole formula are the more nearly in accord with modern practice as observed by the writer.

The results are based on 10 pounds of steam per hour, because the steam consumption of engines per horse power per hour varies widely, and this method allows ready application to an engine of any water rate. Another numerical example will illustrate the use of the table. Let it be required to proportion the condenser surface for a 4,000-horse-power engine using 14 pounds of steam per horse power per hour under 25 inches of vacuum; cooling water from tropical waters at an initial temperature of 75 degrees.

This engine uses 4,000×14=56,000 pounds of steam per hour. According to the Whitham formula, each 10 pounds of steam requires 1.32 feet of surface, and 56,000 pounds will require $\frac{56{,}000 \times 1.32}{10} = 7{,}392$ feet. By the Poole formula we have $\frac{56{,}000 \times 1.08}{10} = 6{,}048$ feet; or by Whitham, 1.85 feet per horse power, and by Poole, 1.51 feet per horse power.

If the engine is assumed to carry 25 per cent. overload, the surface will be, of course, increased in proportion; and if, as is not uncommon, the rate of steam consumption increases with the overload, say 5 per cent., then the surface by Poole's formula will be 6,048×1.25×

1.05=7,938 feet. Another point brought out by the table is the rapid increase of surface and quantity of water required to produce the higher degrees of vacuum, 28 inches of vacuum requiring from 50 to 75 per cent. more surface than 25 inches of vacuum. Again, it appears from the table that it is practically impossible to secure the higher vacuums with cooling water at the high initial temperatures. Still another point is the advisability of having separate air and circulating pumps for cases where the temperature of the cooling water is likely to vary, as in ships trading from north temperate to tropical climates. For instance, in the above example the circulating pump is required to handle from 1,030,400 to 1,601,600 pounds of water per hour if the initial water temperature varies from 60° F. to 80° F. The load on the air pump is practically constant, and if the pumps are separate, as in the cut, the speed of the circulating pump may be changed to suit the work, while that of the air pump remains unchanged.

SPEED LIMITS IN SHOAL WATER.

BY A. D. STEVENS.

The retarding effect of shoal water on the speed of vessels is a well-known fact, and one that has been of special interest to the writer during the last ten or twelve years, in which he has been engaged in the design and construction, and, to a considerable extent, operation of steam vessels in very shallow waters. In studying the problem of speed in this class of boats, it has been noticed that on certain routes, where the water was limited, all the fast boats that have from time to time been put on these routes in the effort to beat competing vessels have somehow lost their reputed speed and proved no faster than their competitors.

Knowledge of these things has prompted a closer study of the problem, and the absence of any data of value in marine engineering publications made it neces-

Vacuum—Inches of Mercury.		24	25	26	27	28
Absolute Pressure—Lbs. per Sq. In.		2.90	2.42	1.93	1.44	.94
Temperature of Steam	$= S$	141°	133°	125°	114°	100°
Temp. of Condensed Steam	$= S - 10$	131°	123°	115°	104°	90°
Final Temp. of Cooling Water	$= F$	125°	117°	109°	98°	84°
Initial Temp. of Cooling Water = I.	60	1.00 .88 162	1.09 .93 184	1.21 1.02 218	1.41 1.16 284	1.79 1.40 455
	65	1.05 .91 175	1.16 .99 204	1.27 1.07 242	1.51 1.22 327	1.95 1.49 575
	70	1.09 .95 191	1.23 1.03 225	1.37 1.13 274	1.64 1.30 385	2.16 1.64 780
	75	1.18 1.00 210	1.32 1.08 252	1.48 1.19 314	1.79 1.39 469	2.43 1.80 1210
	80	1.26 1.24 233	1.41 1.14 286	1.60 1.26 368	1.97 1.52 600	

Upper line in each square = Surface by Whitham formula $U = 210$.
Middle " " " " = " " Poole " $U = 300$.
Lower " " " " = Pounds of Cooling Water per hour.

SQUARE FEET OF COPPER COOLING SURFACE AND POUNDS OF CIRCULATING WATER TO CONDENSE 10 POUNDS OF STEAM PER HOUR.

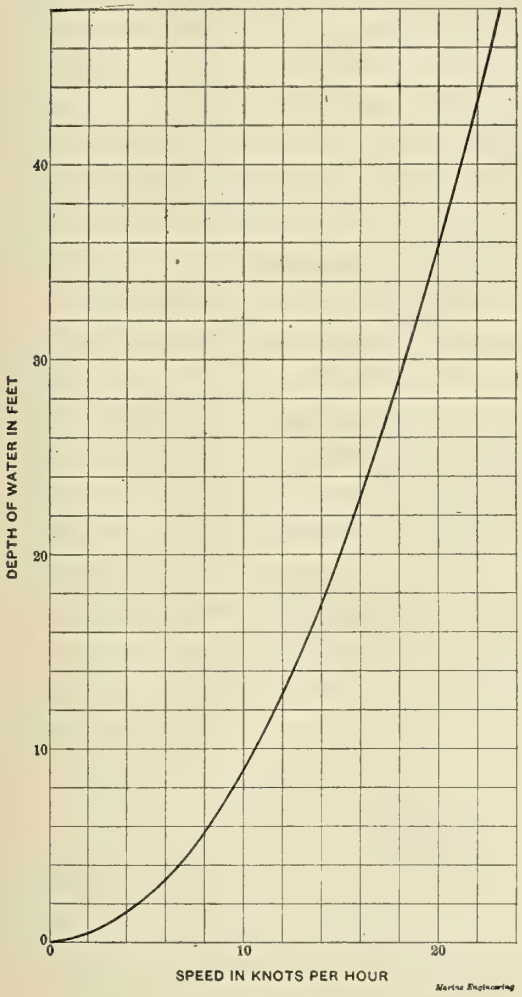
Shipyard Deal Completed.—The Bethlehem Steel Company has been formally transferred to the United States Shipbuilding Company, and the organizers of the combination state that the shipbuilding company will start in business under the new management at once. The capital has been increased from $20,000,000 to $45,000,000. Orders for two vessels have been secured.

Consolidation of Oil-Producing Property.—It is reported that the various oil-producing plants of California are to be consolidated into a $20,000,000 trust. Tank lines are to be laid from the oil fields to the cities of that state, and the object will be to build tanks for storage of fuel oil at the leading coaling stations all over the world. Thirty of these tanks are already completed, and fourteen are now building.

sary to try and find the underlying principle governing speeds in shallow waters. From an obvious course of reasoning, it would seem apparent that the solution must be looked for in connection with wave-making: for, since any vessel going through the water creates a following wave, or, more correctly, wave of displacement, traveling at exactly the same speed of the boat, it then follows that no vessel can run faster than her wave of displacement, and the relation between this wave and the depth of water will be in a great measure the solution of the problem.

Now, if the greatest speed of the boat is at the same time the speed of its wave displacement, then the greatest speed of a boat in any given depth of water is the greatest possible speed of a wave in that depth.

According to the formula of Prof. A. G. Greenhill, in *Encyclopædia Britannica,* the speed of a wave in a depth h, when h is small in proportion to the length of the wave—which is always the condition existing in the case in hand—the velocity of such a wave is expressed in the formula $V^2 = gh$, when V = velocity in feet per second, and h the depth of water in feet. By substitution, the formula reduced to knots per hour becomes $h = .089S^2$, when S = speed in knots, and is shown in the accompanying diagram. Therefore, granting (1) that no vessel can outrun her wave of displacement, for, if she did, there would be a constantly lengthening hole in the water left behind her; and (2) that Prof. Greenhill's formula is correct, then the following can be stated as the laws governing the speed of vessels in shallow water:



CURVE OF LIMITING SPEED IN SHOAL WATER.

First Law—The maximum possible speed of any vessel in shallow water is the limit of the speed of her wave of displacement in that depth of water, and,

Second Law—The maximum velocity of a wave in any shallow water of a depth h is $V^2 = gh$, which is also the maximum speed of a vessel in the same water. So much for the theoretical part. The writer has made such observations as were possible during the last four or five years since he hit upon the above theory, and would say that, as far as could be observed in the course of practical experience with speeds of from 6 to 13 knots per hour with vessels of from 12 inches to 9 feet draft, he has found no instance where the speed exceeded that given by the formula, but that the behavior of every vessel seemed convincing proof of its correctness. In smaller craft, and with speeds from 10 knots down, many observations have been made, all showing that, no matter how much power, how light the draft, or how fast the boat in good water, it could not exceed the formula speed. A boat drawing but 12 inches, and going 8 miles per hour, slacked speed just as promptly where depth fell below that given for 8 miles as did one drawing 3 feet.

The writer does not want it to be understood that the statements above are that all boats are equally fast in the same depth of water; for it is obvious that the size, and shape, and power of boats have much to do with their performance in shallow water. What is meant to be stated is that there is a limit of speed in each depth of water which no vessel can possibly exceed, but which she may more nearly approach the better she is adapted for shallow-water running. It is, moreover, certain that the effect of shoal water is often very apparent long before this speed limit is reached, and, if some series of experiments could be made in model testing tanks, possibly some law governing this effect could be discovered, or, at least, valuable data accumulated concerning the best form of hull for shallow waters. A notable instance of this shoaling effect was seen in the *Erie City-Tashmoo* race, a careful study of which will show that when the *Erie City* was slowed by the shoal water she was approaching closely to the speed limit for that depth.

This article is given as the result of personal observation and investigation, with the hope that others who have been working on the same lines may be induced to give their results, and thus throw light on a subject which is of much importance to this section (Florida), at least.

Dynamite Cruiser Dismantled.—The U. S. S. *Vesuvius,* which was armored with three stationary pneumatic dynamite guns, is to be dismantled. The Secretary of the Navy has reached this decision owing to results of many tests of this gun, both in the army and navy. A battery of these guns at Sandy Hook, costing $300,000, was recently disposed of for $20,000. During the Spanish war the *Vesuvius* demonstrated, at Santiago, the uselessness of her armament, as none of the many shells thrown by her guns took effect.

A New Diving Machine.—For the purpose of locating the wreck of the *Rio de Janeiro,* which went to the bottom of San Francisco bay about twelve months ago, John A. Bower has built a new form of diving machine which somewhat resembles a conning tower. It is of cast iron and large enough to carry a man, and has a powerful searchlight located in it, and an ingenious mechanical arm is placed on the outside and operated from within, which can be used for picking up large or small boats or for fastening grapples. In this tower the inventor intends to explore that part of the bay where the wreck is supposed to be located.

SUGGESTIONS AS TO THE PREVENTION OF CORROSION OF TAIL-END SHAFTS.*

BY JOHN BODDY.

In placing a short paper before the members of this Institute, it is not my intention to raise a discussion on the causes of failures of tail-end shafts, but rather to describe the appliances which I have used for the prevention of corrosion, together with the system of lubricating such shafts and the actual results attained.

The importance of the prevention of corrosion of tail-end shafts, and the necessity of lubrication in the stern tube, stern bush, and neck and gland bushes, will, I am sure, be agreed by all.

If some of our members who have used, and are still using, appliances for preventing corrosion of tail-end shafts and for lubricating stern bushes will kindly give us their experiences I am sure we shall one and all derive some benefit.

During the month of February, 1897, one of the steamers under my superintendence was lying in dry-dock undergoing repairs after grounding. The tail shaft at this time was uncoupled and drawn in for the purpose of being examined. It was then found to be in good order, with the exception of some slight corrosion which existed between the brass sleeves adjacent to the forward end of the after brass liner, and the lignum vitæ in the stern bush was worn down about 1-8 inch. This tail shaft and stern bush were the same age as the vessel, viz., two years. Owing to the corrosion that existed I decided to fit appliances by means of which the shaft and stern bush would be supplied with a lubricant at any time, either when the ship was laden or in ballast trim, and by this means I hoped that further corrosion of the shaft would be prevented.

A hole was drilled through the top of the stern tube, just clear of the forward end of the stern bush, to which were fitted a stopcock and a copper pipe, 1-2-inch bore, leading from top of stern tube through the peak tank, after store room and poop deck, and terminating in the cabin companion. This pipe is shown at *A* on the sectional drawing herewith appended, and was fitted for the purpose of conveying a lubricant to the tail-end shaft and stern bush.

This copper pipe was fitted with bends in the peak tank and after store room to enable it to better adapt itself to any working or vibration that might take place, and secured with clips in the peak and store room. In order to facilitate oil being poured into the pipe it was made funnel shape at the upper end, which was left open.

The object in drilling the hole in the stern tube close to the forward end of the stern bush was that the oil, after entering the stern tube, would, in addition to lubricating the stern bush, be conveyed the whole length of the shaft by the outside water pressure, and by this means the shaft between the sleeves would be coated with grease.

At the under side of the stern tube a drain pipe was fitted and led through the peak bulkhead, with a stopcock fitted on the forward side of bulkhead; this pipe was for the purpose of draining the stern tube clear of sand, grit, or other foreign matter.

*Paper read before the Institute of Marine Engineers.

The chief engineer's instructions were that, at the earliest possible opportunity after the vessel left a port and when the engines were in motion, he himself must empty into the funnel at the top end of the oil pipe one-half of a pint of engine oil, and repeat this every morning while the machinery was working. The oil used for this purpose is the same as that in use for lubricating the engines.

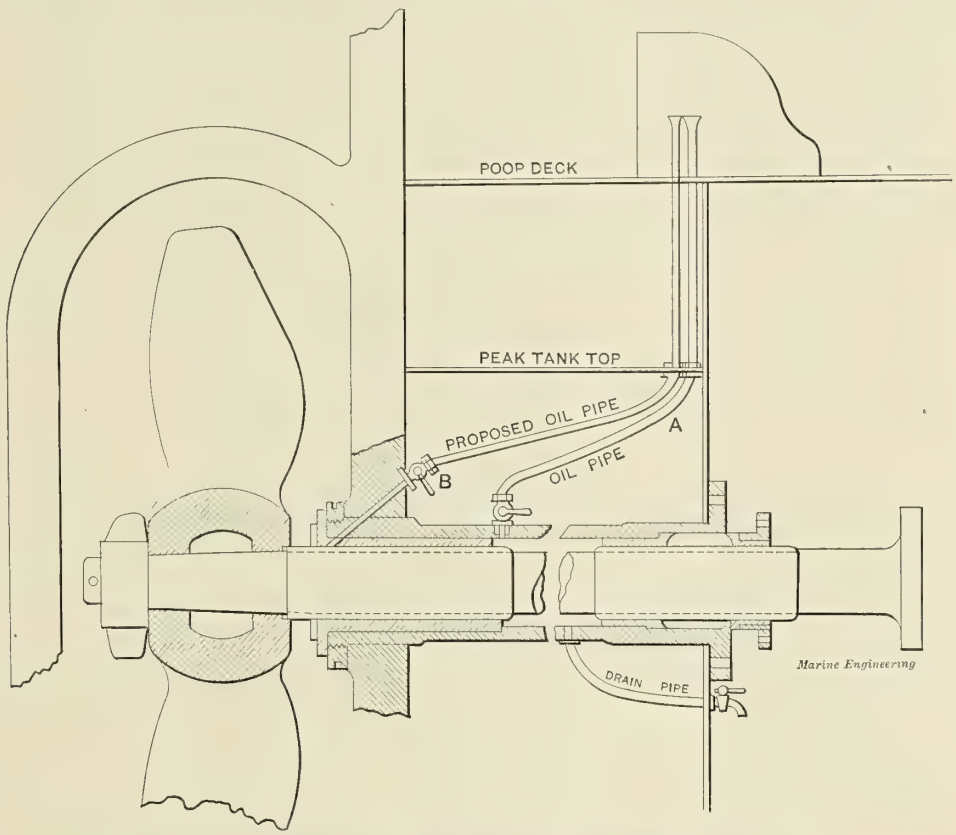
About four months after this oil pipe was fitted the vessel was chartered to proceed from Newport, in ballast, to Barry Dock to load outward. I then took the opportunity of making the trip with her, and before leaving Newport the bent copper pipe was disconnected from the stern tube and a temporary straight length of iron pipe substituted. After the vessel was clear of the port, and when the engines were running full speed ahead, I emptied one-half of a pint of oil into the top of the iron pipe. About ten minutes later I passed a sounding rod down the pipe and rested the point on the top of the tail shaft. On withdrawing the rod I found it indicated a depth of 1 1-2 inches of liquid, the shaft at this point being immersed about 2 feet. After the vessel was moored in Barry Dock, and the engines at rest, the sounding rod was again passed down the iron pipe, when it indicated a depth of about 2 feet of liquid; this corresponded with the shaft's immersion. During the run from Newport to Barry I went along the tunnel and saw that a soapy lather was oozing round the shaft in way of the stern gland. The engineer informed me that when the engines were working there was always a soapy lather at the stern gland.

At intervals during the past four and a half years this vessel's tail shaft has been drawn in for examination, and on each occasion it has been found thickly coated with grease the whole length between the brass sleeves, and quite clear of corrosion or water marks of any description. The lignum vitæ in the stern bush showed very little, if any, further signs of wear since the oil pipe was fitted, until the examination was made, viz.: During the month of March this year, when, owing to the vessel having grounded badly, she was placed in dry-dock, and, in addition to other parts of the engines being opened out, the tail shaft was recommended to be drawn in for examination.

On examining the tail shaft it was found, as on previous occasions, to be thickly coated with grease between the brass sleeves, and no corrosion or water marks of any description existed; the lignum vitæ in stern bush was found to be badly cut and damaged, and a quantity of sand and grit was found inside the stern tube. The stern bush, after having been in use for six years, was taken out, relined with lignum vitæ (end grain), machined, and replaced. The stern tube was cleared of sand and grit and washed out, and the tail shaft, which had also been in use six years, was refitted and coupled.

Other steamers under my superintendence are fitted with appliances similar to the one I have described in this paper, for the purpose of lubricating the tail shaft, stern, neck, and gland bushes, and so far have given satisfactory results. To prevent corrosion of tail shafts at the forward end of the cone, the best means I have found is to have the propeller recessed, and the brass sleeve on the tail shaft fitted and projecting into a recess about 3-8 inch, with an india-rubber ring fitted

in the recess, fairly tight, between end of brass sleeve and end of recess in the propeller. On the accompanying sectional drawing of tail shaft and stern tube you will observe, as shown at *B*, a suggested oil pipe arrangement for conveying oil from the deck to the stern bush, delivering the oil about 2 inches inside the after end of bush. I have not tried or tested this means of lubricating the stern bush, but I am of the opinion that if oil was conveyed and deposited at the after end of stern bush the outside water pressure would be sufficient to prevent the oil escaping outward, and force it the whole length of stern bush and tail shaft, and thus the stern bush would be lubricated, the tail shaft protected from corrosion between the sleeves, the neck and gland bushes would also be lubricated, and the lifetime of each would be considerably prolonged.



METHOD OF LUBRICATING STERN TUBE TO PREVENT CORROSION OF TAIL SHAFT.

DISCUSSION.

Mr. W. Simpson said presumably the method of lubrication described answered its purpose, as it was not often they heard of a tail-end shaft running for six years. Whether lubrication, however, was all-sufficient was questionable. They had heard members prove to their own satisfaction that it was the fitting of sleeves on to tail-end shafts that was the starting of corrosion. He was afraid that when once corrosion started it could not be stopped. Mr. Boddy spoke of half a pint of engine oil being put down the pipe. It seemed to him it would take a long time before the oil reached the shaft and did any practical lubricating. Some time ago he adopted a similar plan to that described, but without the drain pipe. He pumped the stern tube full of vaseline, and gave instructions to the engineer to fill the 1 1-4-inch pipe every day until he found what quantity he required to use. Most of the systems he had seen and heard of had a stern gland outside. He should like to ask Mr. Boddy if his experience led him to think that it was quite sufficient to have the pipe without the outer gland on the stern bush, whichever way it might be fixed. The speaker's shaft ran on white metal, without sleeves. It had been running about twenty months, and he had left the outer gland off, with the idea that if he had a head of oil he could force the water out. So far he had found it work all right. If he had a gland and the thing was neglected he would have no lubrication, whereas without a gland he still had the water, the same as he had before, only his was working to white metal, and this of Mr. Boddy's was brass to lignum vitæ.

Mr. T. A. Johnson said they required to first remember that the real cause of the corrosion of a shaft was galvanic action. In his experience he had come across shafts where the element of corrosion was absolutely eliminated by a patent stern tube, and the shaft broke just the same. A favorite remedy advocated was a continuous liner. A superintendent engineer had told him of the case of the *City of Rome*, where a shaft, 25 1-2 inches in diameter under the sleeves, of Whitworth's compressed steel, over 20 tons weight, with a very heavy propeller, had been running since 1880. No corrosion, no breaking of the shaft. With regard to the paper, he did not know whether Mr.

Boddy inferred that the stern tube was empty when the ship left the dock, or whether it was filled with oil prior to the vessel leaving. He presumed Mr. Boddy first filled the stern tube. (Mr. Boddy: No, sir.) Well, he had not come across the practice, but he could quite understand that the centrifugal motion which took place in the water must mix up the oil, which would gradually work on to the shaft. Yet he should have thought it advantageous to give the shaft a start by putting the oil in direct. There were other causes of fracture which should not be lost sight of besides corrosion. As they knew, he had been located in a place which was the back door to the Atlantic ocean, and of broken shafts which came in their name was legion. There was, for instance, the friendly tap of the engineer to harden up the nut. This was the cause of fracture in one case. Then he had seen lots of shafts from which big pieces had come out, the size of your fist, showing that the homogeneity of the shaft had been doubtful. But the whole crux of the matter lay in the fact that shafts had been too small in diameter. With a larger shaft they would get longer lives, which would be a bad job for the poor unfortunate ship repairer. Another cause of mischief to shafts arose from the piece of india rubber which Mr. Boddy described as introducing between the propeller and the end of the liner. Great care needed to be exercised in fitting on the rubber. He had come across four cases where the slackness of the propeller was due to the fact that the india rubber could be screwed up into such a position that it had the back tendency of a very strong spring, with the result that when the propeller was hard up against it the tendency was to drive it off.

Mr. A. R. Watson said a half-pint of oil seemed a small quantity to result in such benefit as Mr. Boddy claimed. Then he thought Mr. Boddy was wrong in the proposed lubrication of the shaft 2 inches from the end of the bush. He could not see anything to prevent the oil simply going straight out, unless there was a circulation of water coming back over the tube, which they could not have unless there was a very large drain cock running into the tunnel all the time. His own experience was that exceedingly satisfactory results were obtained from plain shafts running on a cast-iron bush, with an outside gland. One such shaft had been running over two and a half years, and the last time it was drawn in it had worn barely a thirty-second part of an inch. This was not guesswork, but from a gage made at the time the shaft was fitted new. In a good many cases of accidents to lubricated shafts that had come under his notice the defect was due to the faulty fitting of the lubricant. They could not expect to retain in a stern tube oil which had a natural tendency to flow outward and upward. Some of the older shafts with which he had to do had been running in solidified oil for about six years, with satisfactory results, both as to the wearing of the shaft and of the lignum vitæ.

Mr. D. Roberts could not reconcile the figures given by Mr. Boddy as to the sounding rod and the depths of liquid found upon an occasion ten minutes after the first. He presumed that the point of the paper was: that by getting oil on to the shaft water was prevented coming into contact with the shaft, sea water on the brass being the prime cause of corrosion, and the effect of sea water setting up galvanic action. It might be that the action of Mr. Boddy's oil had prevented an inflow of sea water into the tube. He should like Mr. Boddy's opinion upon this point, because he had never seen the experiment tried. He knew of a shaft with a liner in white metal which had been running for a period of eight years, the ship trading in dirty water and sand. The shaft was fitted with a pipe similar to that described, but a fixed quantity of oil was not put in, the oil being kept a certain head above the stern tube, the head being proportionately reduced when the ship was in light trim. The white metal was renewed last year, after eight years. On the other hand, he had a shaft the other day, barely two years old, with a very severe fracture, although there were few signs of corrosion. He considered the quality of material had a great deal to do with shaft failures. He had examined the shaft of the *City of Rome*, referred to by Mr. Johnson, with the Board of Trade Inspector, who demanded that a hole be driven at certain points through the liner. The metal came out perfectly clean, there being no sign of corrosion. At that time there was some doubt as to the after end of the liner. The propeller was fitted with a rubber ring, and there was no sign of corrosion in the position occupied by the ring. The ring was fitted just sufficient to touch the propeller when it was up at its highest position.

Mr. Simpson asked Mr. Roberts if there was an outer gland on the shaft he had spoken of as running eight years. Mr. Roberts replied in the negative.

Mr. C. W. Hansen asked if Mr. Boddy had the drain cock open at the first suffusion of oil. If not, how did he account for its getting down there at all?

The discussion was then adjourned.

(To be continued.)

Monthly Shipbuilding and Returns.—The Bureau of Navigation reports 119 vessels of 31,469 gross tons were built in the United States and officially numbered during the month of August, 1902. The largest steam vessel included in these figures is the *Siberia*, of 11,284 gross tons, built at Newport News, Va., for the Pacific Mail Steamship Company.

Wireless Telegraphy.—Admiral Bradford, who is in charge of the naval experiments in wireless telegraphy, has reported that by the Rochfort system messages have been successfully transmitted between Washington and Annapolis. Three other foreign systems are soon to be tested by the Navy, but it is evident from Admiral Bradford's report that the United States is far behind other nations in the use of wireless telegraphy.

Steam Turbines for Merchant Ships.—The application of the steam turbine to marine propulsion so far, with the exception of the two Clyde passenger steamers, has been confined to pleasure or naval craft. However, in asking for proposals for a new steamer for the Irish Sea service, the Lancashire and Yorkshire Railway Company invite alternate proposals for the ships to be equipped with the ordinary twin-screw reciprocating engines, and also for steam turbine propelling engines. The speed required is 17 knots, which is to be attained on the minimum of dimensions consistent with securing the accommodation necessary for a large number of passengers and cattle.—*Engineer.*

A Collision Bulkhead in Service.

The accompanying illustration shows in a most striking manner the possible utility of the collision bulkhead. Neither the name of the ship nor the details of the collision in which she took part are necessary to point the lesson which is here taught. The one fact which the illustration emphasizes is that in this case, at least, the bulkhead was the salvation of the ship. It will be noted how completely the bow has been torn away, and in part folded over on the bulkhead, which, on the upper part, seems to have been overlaid with planking. The inrush of water through a gaping rent, such as here shown, would, without the bulkhead, have soon filled the ship, settling more and more by the bow as the water came in. Many similar instances have occurred, and the collision bulkhead needs no emphasis placed on its possibilities for good. Rarely, however, has it been possible to show so clearly by photographic reproduction the extent of the damage and the condition of the bow after the collision as in the case illustrated in the above engraving.

BOW OF A STEAMER AFTER COLLISION; THE VESSEL WAS KEPT FROM SINKING BY THE FORWARD COLLISION BULKHEAD.

Improvements in Shallow River Navigation.

The systems of propulsion available for shallow river navigation are:

Firstly, by paddles, one being placed on each side of the vessel, which system is familiar to every one accustomed to travel on European rivers.

Secondly, the stern-wheel system, the paddle wheel being in this case placed at the stern of the hull. This plan is adopted to a large extent on the rivers of North and South America. Both these systems have the disadvantage of reduced efficiency when the vessels are loaded and consequently deeply immersed, unless feathering wheels are adopted, which is a device costly to maintain in good working order. Also the weight of this class of machinery is great, and the space occupied considerable, as compared with a screw-propelled vessel. Moreover, the wheels, especially in the side-wheel system, are exposed to damage by floating timber, and in any case the width of channel required with a side-wheeler is increased by the width of the wheels.

The ordinary screw-propelled vessel is not applicable when the draft is very limited, on account of the want of ample immersion for the propeller to secure efficiency. There is a third system of propulsion for shallow-river navigation, consisting of an arrangement of screw propeller which has been brought forward prominently of late; it combines the advantage of a large propeller combined with a shallow draft. The propeller (or propellers in the case of twin or triple screws) revolves in a tunnel formed in the bottom of the hull, near the stern. The upper part of the tunnel is considerably above the water line. This tunnel is semi-circular at the top, and dies away forward toward the midship of the vessel, and also toward the stern aft, the propeller revolving in the tunnel at its highest part, the height of the tunnel at this place being a trifle greater than the diameter of the propeller, so that its lower blades are slightly above the bottom of the boat, and therefore there is no risk of their striking the ground. When the boat is at rest, the upper part of the tunnel above the water line is filled with air, the water line in the tunnel being level with the water outside, but the moment the propeller commences to revolve the air is driven out of the tunnel and replaced by water; thus it will be seen that a propeller whose diameter is in excess of the draft of the vessel is enabled to work efficiently in a solid column of water, although not projecting below the bottom of the hull. This system has been adopted in modern times to a considerable extent, notably in a number of shallow-draft gunboats built for the British Admiralty for service in East Africa, on the Nile, and, more recently, on the China rivers. The two last gunboats of this type that have been sent out to the East bore the names of the *Teal* and *Moorhen*. For gunboats there is no doubt this system offers special advantages, but for cargo-carrying purposes, or for towing, where there may be large variations of draft, it involves a loss of efficiency when the vessel is loaded, owing to the after end of the tunnel being lower than is required at the deep draft, the rush of water from the screw striking this inclined surface, thereby forming a serious drag. At the same time, when the vessel is in its lightest condition it is necessary that the after end of the tunnel should terminate below the level of the water; otherwise air will gain access to the tunnel and completely upset the system, because in the event of air being admitted the propeller no longer works in solid water. Now the improvements recently introduced by Messrs. Yarrow and Company secure considerably increased efficiency in the loaded condition of the vessel and admit of large variations of draft. The after part of the tunnel works on a hinge, so that it can be raised or lowered to suit variations in the immersion of the vessel, the after end always being a trifle below the water level. It is easy to understand, with this arrangement, that the minimum inclination of the top of the tunnel to suit the conditions of draft can be adopted, and the serious reduction of efficiency due to the inclined surface of the tunnel is materially diminished; when the vessel is loaded so that its draft equals the diameter of the propeller, the reduced efficiency due to the rush of water striking the inclined surface of the tunnel is entirely avoided, as the after part of the tunnel would, in this case, be horizontal. The design shows a longitudinal section of the vessel recently tested. It is 75 feet in length by 9 feet 3 inches beam, and has a draft of 11 inches with steam up, but without cargo. A complete series of experiments were made to ascertain exactly the advantage due to the variation of inclination of the after part of the tunnel. It will be seen from Fig. 2 that the flap *A B*, forming the upper part of the tunnel, moves on a center *B*, and when raised up to a horizontal position the point *A* coincides with the point *C*. The usual plan is shown on Fig. 3, the after part of the tunnel being fixed. Fig. 1 shows the flap raised to its fullest extent; Fig. 2 shows the flap lowered to its fullest extent,

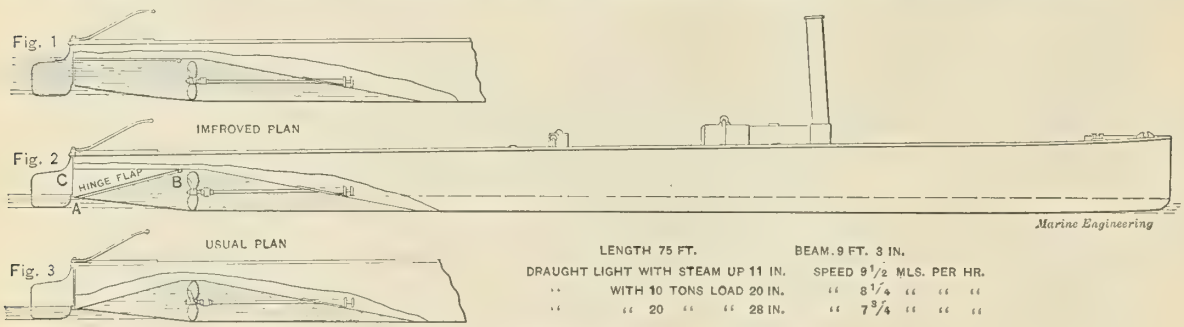


Fig. 1
IMPROVED PLAN
Fig. 2
C
HINGE FLAP
B
A
Marine Engineering
USUAL PLAN
Fig. 3
LENGTH 75 FT. BEAM. 9 FT. 3 IN.
DRAUGHT LIGHT WITH STEAM UP 11 IN. SPEED 9 1/2 MLS. PER HR.
" WITH 10 TONS LOAD 20 IN. " 8 1/4 " " "
" " 20 " " 28 IN. " 7 3/4 " " "

SHALLOW-DRAFT LAUNCH, ILLUSTRATING YARROW STERN.

corresponding to the maximum and minimum drafts of water. The curves of speed and power have been worked out for all conditions of draft.

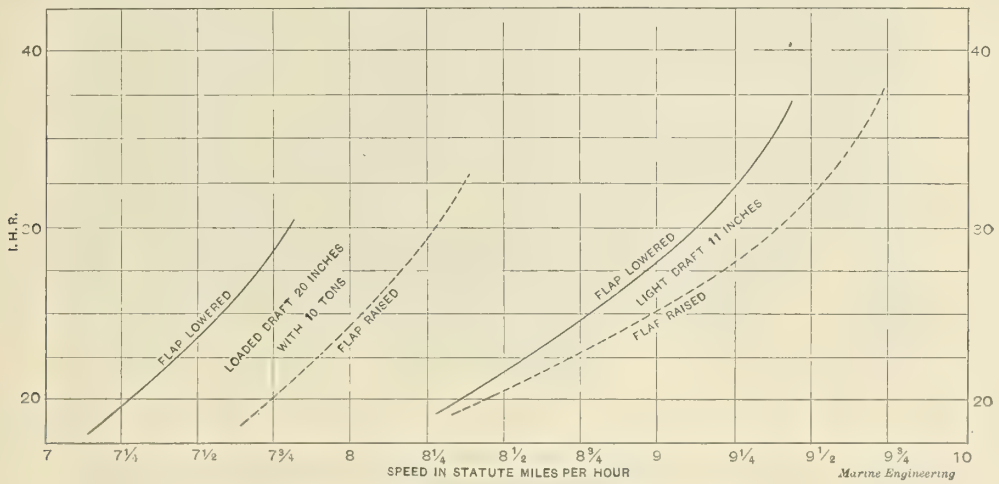
The draft light with steam up was 11 inches, and the speed 9 1-2 statute miles an hour.

With 10 tons load the draft was 20 inches, and the speed was 8 1-4 statute miles an hour.

With 20 tons load the draft was 28 inches, and the speed 7 3-4 statute miles an hour.

Now, taking as an example an average load of 10 tons, the same power is required with the flap lowered (which corresponds to the usual form of construction) to get 7 1-2 miles an hour as, with the flap raised, gives 8 miles an hour. That is to say, there is a gain by raising the flap of 1-2 a mile an hour, the power remaining the same. Now, assuming that the power required is proportional to the cube of the speed—which is nearly correct—the relative efficiencies will be approximately as 4 is to 5; that is to say, there will be a gain of 25 per cent. It was the loss of efficiency due to the water striking the inclined surface that has probably prevented this system being more extensively adopted for vessels having variations in draft, but this difficulty, it will be seen, has been avoided by the present device, and Messrs. Yarrow and Company are of opinion that for light-draft steamers this system of propulsion will probably become extensively adopted, because by this means a better combination of speed and shallow draft is obtained than by any other, together with efficiency with large variations of load.

It will be noticed that the propeller, owing to its being enclosed all round by the hull, is free from risk of damage from floating obstructions; at the same time, it is readily accessible by means of a door placed at the top of the tunnel.



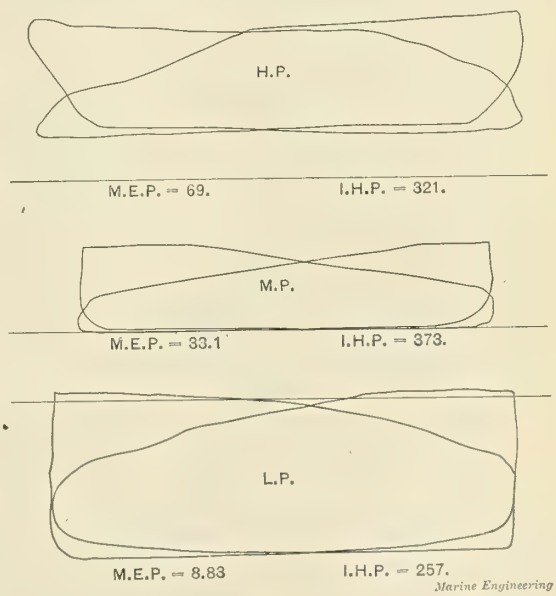
CURVES OF SPEED AND POWER, 75-FOOT SHALLOW-DRAFT LAUNCH.

Japanese Shipbuilding.—The several Japanese shipyards have recently booked orders for many large new steamers. The Nagasaki Dockyard and Engine Works are building four steamers of 6,000, 5,400, 2,500, and 1,900 tons respectively, the larger ones being for the Japan Mail Steamship Company. The other yards have four other ocean-going steamers under way.

Machinery Tests of the Steam Yacht Wacouta.

The steam yacht *Wacouta,* originally named *Eleanor,* was constructed by the Bath Iron Works, Bath, Me., 1893-94. The vessel was built for William A. Slater, of Norwich, Conn., and was especially designed and constructed as a deep-sea cruiser for circumnavigating the globe. Her voyage around the world proved very successful, steaming and sailing, as she did, 42,406 miles in sixteen months. The yacht is bark-rigged and carries an unusually large coal supply. In 1896 the *Eleanor* was chartered to various prominent yachtsmen, and in 1898 she became the property of Mrs. Cardeza, of Germantown, Pa., who, after using the vessel about two years, in turn sold her to James J. Hill, of St. Paul, Minn.

The principal dimensions and features of the yacht are given in the annexed table.



INDICATOR CARDS FROM THE WACOUTA.

The machinery was likewise built by the Bath Iron Works, and during the past winter it has been overhauled and the entire propelling plant modified by the

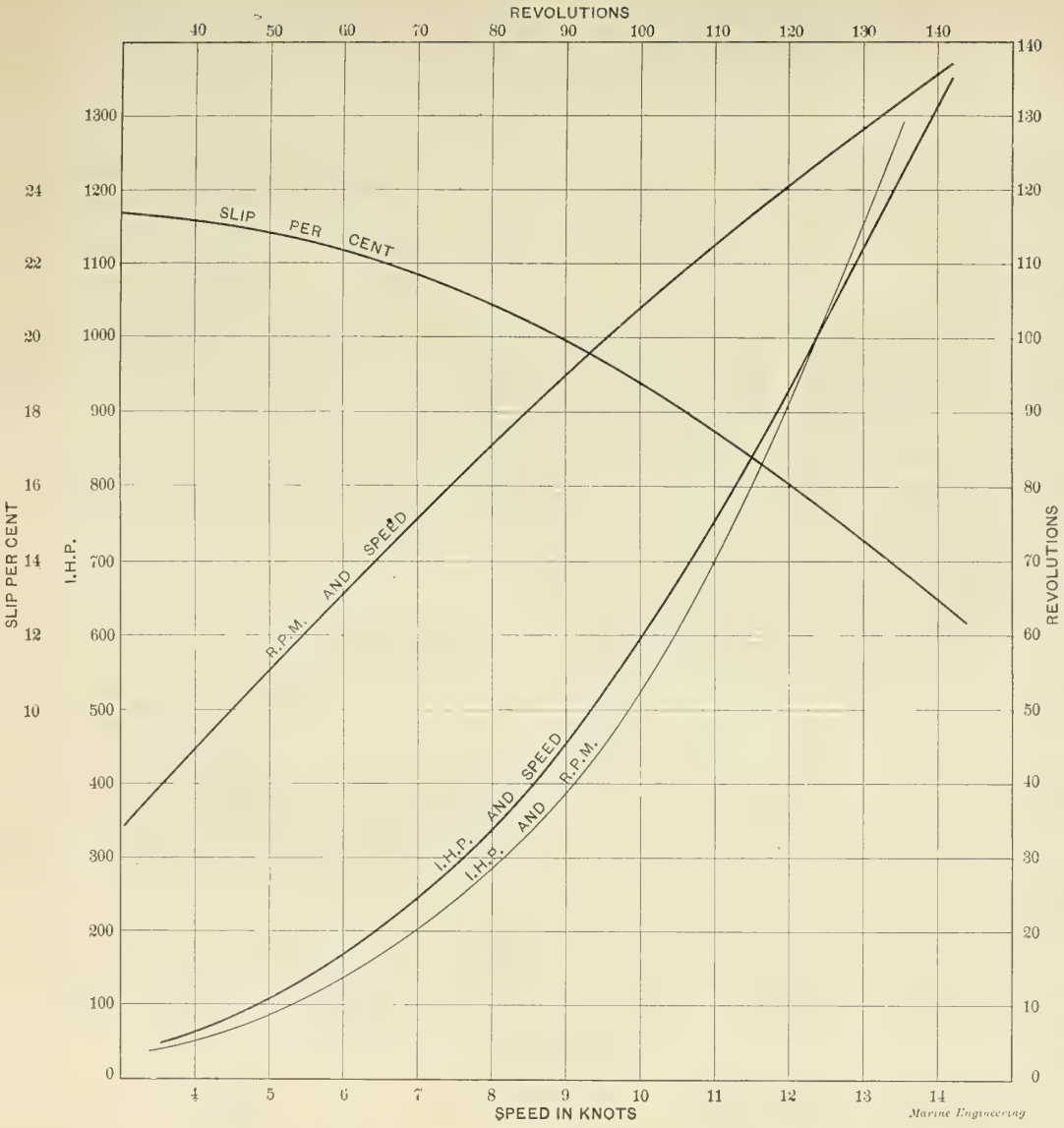
Eastern Shipbuilding Company. The latter company has also made extensive alterations in the hull and added a large pilot house forward, which has much improved the appearance of the ship. There is a three-cylinder, triple-expansion engine. The cylinders rest upon cast-iron housings at the rear, which form part of the condenser, and upon wrought steel columns at the front. There are two main boilers, and one vertical tubular boiler which is 55 inches in diameter and 10 feet 6 inches high. An independent feed pump, circulating pump, ash-ejector pump, fire pump, feed heater, fresh and salt water sanitary pump, ventilating blower, forced draft blower, ice machinery, two dynamos, steam steering gear, steam windlass and evaporator are fitted, and bilge and air pumps are worked from the main engine.

On May 3, 1902, the Eastern Shipbuilding Company conducted machinery tests off New London harbor, under the direction of Superintending Engineer William A. Fairburn, and the result of the observations made cannot fail but prove of interest. The sea was calm, with no wind, a slight mist prevailed, and the atmosphere was very heavy and damp. The vessel was in normal sea-going condition and had a foul bottom, not having been docked for nine months. During the test all the auxiliaries were run from the main boilers. During runs one, two, three, four, and five, the ice machinery, the evaporator, and No. 2 dynamo were not running, the soil ejector, steering gear in operation, also dynamo No. 1, ventilating engine room blower, and the sanitary pumps. In test No. 6 all the auxiliaries except the evaporator were in operation.

STEAM YACHT WACOUTA, BELONGING TO MR. JAMES J. HILL.

NAME—Wacouta. NATIONALITY—American. TYPE—Steam Yacht.
LAUNCHED—1893. BUILDERS—Bath Iron Works. OWNER—Jas. J. Hill.

Length over all	243 ft.	0 in.	
" load water line	208 "	0 "	
Molded beam	32 "	0 "	
" depth at side	18 "	5 "	
" " " center	18 "	11 "	
Depth of hold	17 "	5 "	
Mean draft	12 "	8 "	
" " with keel	13 "	4 "	
Draft aft	14 "	2 "	
Overhang forward	19 "	2 "	
" aft	15 "	10 "	
Freeboard forward	14 "	10½ in.	
" aft	11 "	7½ "	
Dead-rise midships	4 "	10½ "	
Tumble home midships to deck		5 "	
Gross tonnage		803.8 tons	
Net "		401.9 "	
Displacement		1,136 "	
Area midship section		316 sq. ft.	
Wetted surface		7,820 " "	
Block coef		468	
Midship section coef		.794	
Ratio length to beam		6 5 to 1	
" " " depth		11.94 " "	
" beam " "		1.94 " "	
Number of decks		2	
Spacing of deck beams		48 in.	
Spacing of frames		24 in.	
Number of water-tight compartments		18	
Deck erections	One large deck house with pilot house forward over same.		
Sail area		14,036 sq. ft.	
Coal capacity		265 tons	
Water-tank capacity		125 "	
Engines, number		1	
Diameter H. P. cylinder		18 in.	
" M. P. "		28 "	
" L. P. "		45 "	
Stroke		30 "	
Designed revolutions		125	
" I. H. P		1,000	
Cooling surface		1,129 sq. ft.	
Air pump		21 in. by 9 in.	
Boilers		2 single-end Scotch	
Total H. S		4,016 sq. ft.	
" G. S		120 " "	
Ratio H. S. to G. S		33 46	
Ratio G. S. to calorimeter		6.77	
Diameter of boilers		12 ft. 5 in.	
Length " "		11 " 7 "	
" " grate		6 " 0 "	
Diameter of furnaces		42 "	
Number of furnaces, each boiler		3	
Coal per I. H. P. average		1 93 lbs.	



TRIAL DATA TAKEN ON THE STEAM YACHT WACOUTA.

	No. 1.	No 2.	No. 3.	No. 4.	No. 5.	No. 6.
Period of time, minutes ...	37	30	30	30	60	42
Total number of engine rev..	1,790	2,285	3,103	3,605	7,545	5,345
Average rev. per minute.....	48.4	76.16	103.14	120.16	125.66	127.26
Maximum " "	51	77	103.5	121	134	133
Minimum " "	47.5	75 5	103	119	115	117
Vacuum, inches.	26	27 1-2	26 3-4	26 1-2	26.4	26 1-4
Steam press. at boilers, lbs,...	155	155	154	148	153	155 to 142
" " engines, "	154	154	151.5	143 7	151	153 max.
Max. " " boilers, "	155.5	155.5	155	151	155.5	....
Steam press. M. P. rec. "	0	8	26.5	41.75	45	43
" " L. P. " in. vac.	13.1	11.5	1.85	2.75 lbs.	3.4 lbs.	6 1 lbs.
Circulating pump rev.	180	202	220	360	400	400
Feed pump double stroke. .	14.6	18.4	18	23	25	28.5
Temp. of hot well, deg. Fah.	61	62 5	111.5	117	122	112 to 136 average 125
" overb'd discharge....	67	75	91	88	96	80 to 98 average 86
" sea water, Fah.	48	48.5	48.5	48	48	48.5
" engine room, Fah	80	80	79.5	80	83	84. 5 to 87
" fire room, Fah..... .	99	98	98.5	97	110	98 to 108
Revolutions per minute	48.4	76.16	103.5	120	125	131.5
I. H. P. of H. P. cylinder.....	36.5	109	228	318	357	276
" " I. P. "	27.2	81.19	214	337	389	530
" " L. P. " ,.....	19.2	51.29	143.5	252	290	431
M. E. P. H. P. cylinder.....	19.5	37.22	57.1	68.8	74.2	54.3
" I. P. "	6.0	11.45	22.17	30.1	33 35	43 2
" L. P. "	1.6	2.8	5.73	8.78	9.62	13.6
M. E. P. referred to L. P. Cyl.	7.2	13 5	24.01	32.24	35.30	40.17
Total I. H. P.....	82.9	241.48	585.5	907	1,036	1,237
Avge. I. H. P. for entire run .	82.9	241.5	585.5	907	1,100	1,150
Speed, knots	4.54	7.1	9.95	11.85	12.9	13.15

EXPERIMENTAL ELECTRIC LAUNCH.—II.*

BY PROF. OSWALD FLAMM.

(Continued from page 342, July, 1902.)

The boat was given the usual form of modern torpedo-boat stern. Following is the schedule of weights:

Hull and deck house ..... 5.944 tons.
Stern tube, shaft, and propeller.... .207 "
Motive power equipment..... 11.049 "

Having reference to the power trials to be presently described, the weight of machinery equipment was about 408 pounds per horse power. This is admittedly an excessive value and leads us to look for an effort, and we may hope an effective effort, on the part of the electrical engineer to reduce such weights to lower values. In reference to the electrical equipment it should be said that the entire battery was of the so-called "dry cell" type, a form of cell which for marine work has the advantage that in the heaviest sea, and no matter what the motion of the boat, the performance of the battery is the same. In order to conduce to lightness of motor the revolutions of the shaft at full power were taken as not less than one thousand per minute.

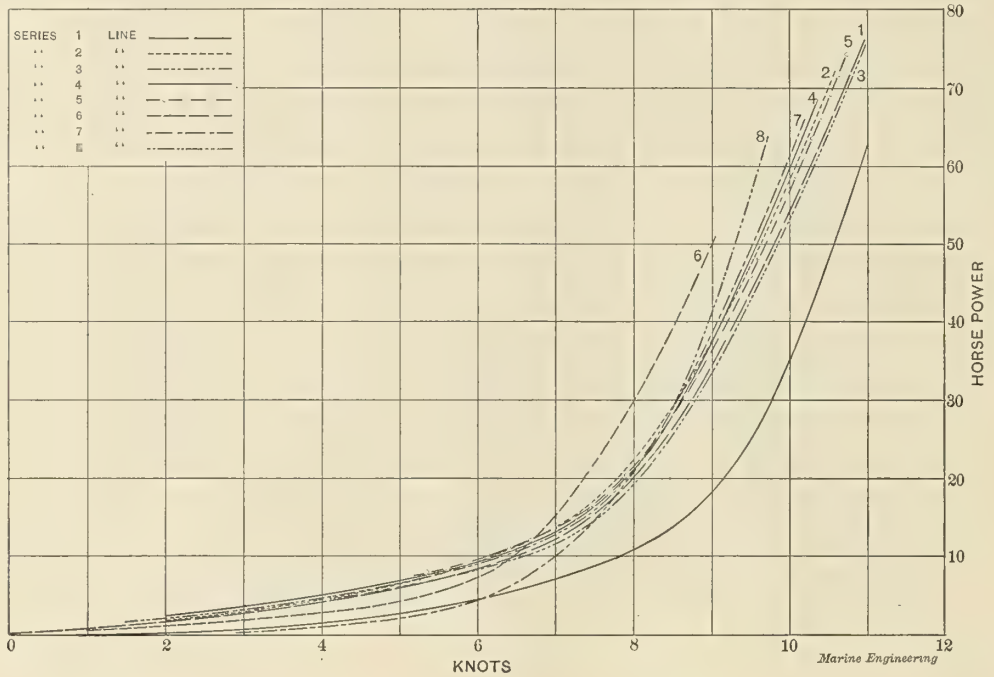


FIG. 6.

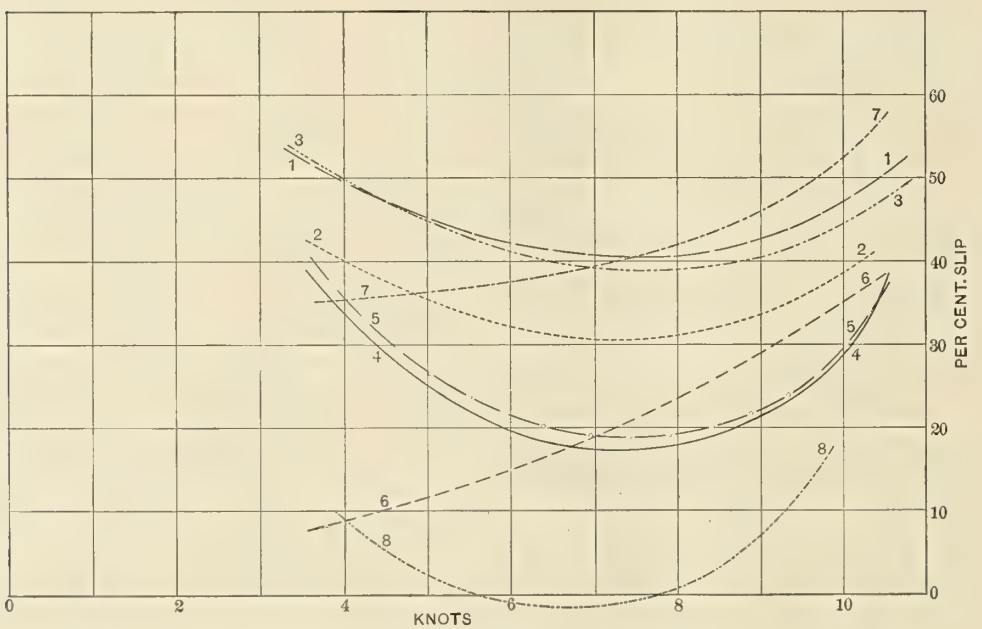


FIG. 7.

*Translated from *Schiffbau*, February 23, 1902.

Two propellers were fitted on the shaft, one aft of the other, and determinations were made regarding the dimensions and working relations of the propellers. The controller arrangement provided for three grades of power and speed. In order to reduce friction losses as much as possible, the thrust bearing was made of the ball-bearing form, and to provide for the elasticity of the boat the nickel-steel line shaft was coupled to the motor shaft with a universal coupling, an arrangement which proved very satisfactory in the trials of the boat.

Number.	Diameter.	Pitch.	Projected Area.
1.....	1.48.....	1.64.....	.39
2.....	1.48.....	1.64.....	.59
3.....	1.44.....	1 17.....	.59
4.....	1.48	1.71.....	.50
5.....	1 77.....	1.17.....	.12

In the accompanying figures are shown curves of horse power, slip, and revolutions for these various propellers. Of especial note is the wide range of slip and

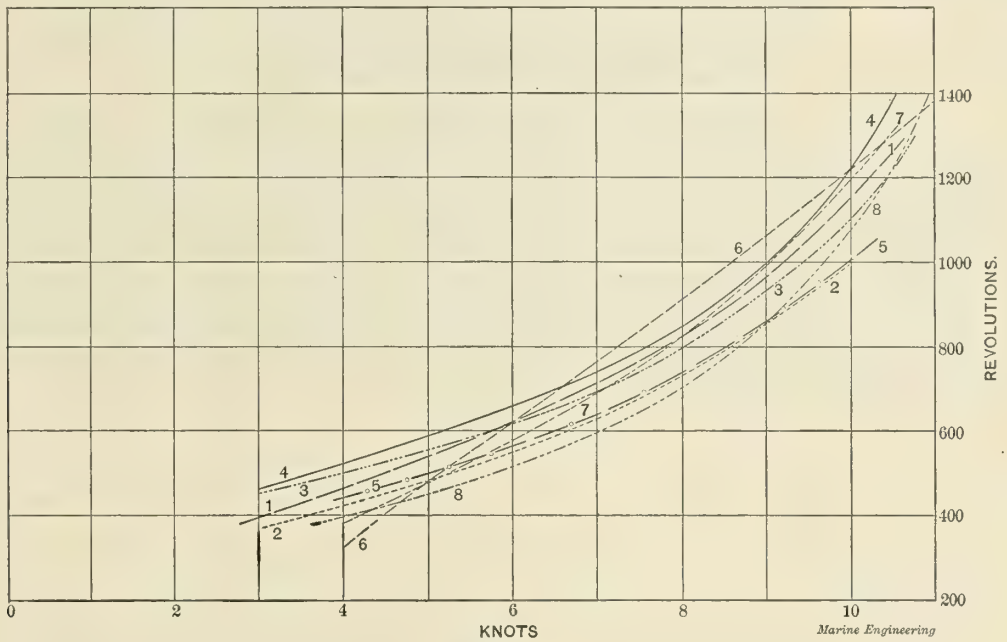


FIG. 8.

In September, 1901, the boat was placed in the water and after a short trial on the Havel went with her own power to Stettin and then to Swinemünde. There trials were carried out, and in stormy weather, which showed the seaworthiness of the boat in a very gratifying manner. The speeds reached on these trials were not such as to warrant any general conclusions. The two propellers fitted were of the following dimensions:

Diameter..... 1.48 ft.
Pitch ..... 1.64 "
Projected Area..... .39 sq. ft.

In order to investigate the influence of the projected area of the propeller blades, a second pair of like construction was fitted of the following dimensions:

Diameter..... 1.48 ft.
Pitch ..... 1.64 "
Projected Area ..... .59 sq ft.

The entire series of tests indicated that these propellers should give somewhat better results than those first fitted. Regular and complete tests, however, were not carried out till November on the Tegeler See. In these tests the speed was not taken over a measured mile, but by three carefully rated patent logs. The speeds of Table II. relate solely to the indications of these logs. In connection with the later trials, extended tests of propellers were made of the following dimensions:

the especially low values to which it was reduced in certain cases. These, however, gave an uneconomical result. Note may also be made of the performance of the large propeller, whose area was equal to that of the two small ones. In the results there often appeared together higher slip and lower horse power with greater speed. The highest speed reached lay in the neighborhood of ten knots.

The trials of this boat indicate at least that we may hope, through the further combined efforts of the electrical engineer and the shipbuilder, for further and still more satisfactory developments in electrical boat propulsion.

TABLES I.

SERIES I.

One Propeller, No. 1, aft. Sea smooth.

Speed in Knots.	Wind.	Battery Volts.	Motor Volts.	Amperes.	Horse Power at Motor.	Revolutions.	Slip.
4.48	against	80	76	48	4.96	522	.470
4.58	with	80	76	46	4.75	526	.460
7.50	against	80	76	155	16.	768	.398
7.50	with	80	76	150	15.5	766	.398
7.50	against	157	75.5	75	15.4	780	.408
7.42	with	156	75.5	75	15.4	770	.408
9.78	against	149	144	258	50.5	1105	.453
9.74	with	148	143	254	49.4	1105	.457

Series 2.

Two Propellers, No. 1.

Speed in Knots.	Wind.	Battery Volts.	Motor Volts.	Amperes.	Horse Power at Motor.	Revolutions.	Slip.
5.22	with	81	78	50	5.03	477	.324
4.52	against	82	78	53	5.62	461	.395
7.62	against	80	76	177	18.25	688	.317
7.66	with	80	76	177	18.25	695	.319
7.88	with	157	152	87	17.95	695	.298
7.74	against	158	152	90	18.60	692	.308
10.12	with	150	144	302	59.00	1010	.382
9.94	against	151	144	305	59.60	1020	.400

Series 3.

One Propeller, No. 2. Sea smooth.

Speed in Knots.	Wind.	Battery Volts.	Motor Volts.	Amperes.	Horse Power at Motor.	Revolutions.	Slip.
3.96	against	82	78	48	5.08	508	.520
4.48	with	81	78	50	5.30	510	.458
7.62	against	81	77	162	16.95	758	.400
7.48	with	81	77	158	16.50	762	.395
7.60	against	158	152	76	15.70	760	.390
7.60	with	158	152	76	15.70	753	.383
9.88	against	149	144	265	51.80	1095	.444
9.88	with	150	144	265	51.80	1088	.440

Series 4.

One Propeller, No. 3.

Speed in Knots.	Wind.	Battery Volts.	Motor Volts.	Amperes.	Horse Power at Motor.	Revolutions.	Slip.
4.14	.....	82	80	50	5.44	520	.313
7.54	.....	82	78	152	16.10	782	.165
7.54	....	161	156	72.5	15.35	780	.164
9.60	.....	154	147	265	51.00	1138	.265

Series 5.

Two Propellers. Forward No. 3, Aft No. 2.

Speed in Knots.	Wind.	Battery Volts.	Motor Volts.	Amperes.	Horse Power at Motor.	Revolutions.	Slip.
3.82	against	81	38	55	5.67	457	.40
4.84	with	80	38	55	5.67	480	.27
7.74	against	80	76	177	18.25	686	.19
7.74	with	79	76	173	17.85	690	.19
7.74	against	157	75.5	85	17.40	686	.17
7.54	with	157	75.5	82	16.85	690	.22
9.88	against	146	139	293	55.30	1000	.29
9.88	with	146	139	290	54.75	995	.28

Series 6.

One Propeller, No. 3, forward. Sea rough.

Speed in Knots.	Wind.	Battery Volts.	Motor Volts.	Amperes.	Horse Power at Motor.	Revolutions.	Slip.
5.12	against	83	39	44	4.66	508	.15
5.36	with	82	39	47	4.98	513	.10
6.90	against	81	76	154	15.90	756	.21
7.20	with	80	76	152	15.70	762	.18
8.62	against	151	140	214	40.70	1005	.26
8.74	with	146	139	211	39.80	1000	.26
8.67	against	142	135	260	47.70	1070	.30
8.80	with	140	133	257	46.40	1062	.28

Series 7.

One Propeller, No. 4, aft. Light wind.

Speed in Knots.	Wind.	Battery Volts.	Motor Volts.	Amperes.	Horse Power at Motor.	Revolutions.	Slip.
9.63	with	154.5	146	255	50.6	1110	.962
9.20	against	150.5	142	251	48.5	1110	.962
9 22	against	150	142	215	41.5	1018	.882
7.65	with	156	150	70	14.25	757	.656
7.38	against	80	75	149	15.20	757	.656
5.58	with	80	38	43	2.22	528	.458

Series 8.

One Propeller, No. 5, aft. Rough water.

Speed in Knots.	Wind.	Battery Volts.	Motor Volts.	Amperes.	Horse-Power at Motor.	Revolutions.	Slip.
4.56	against	80	78	58	6.15	443	.107
5.22	with	82	78	54	5.72	447	.0002
7.88	against	80	77	186	19.45	668	.0002
7.74	with	80	77	183	19.15	670	.000
7.98	against	156	152	92	19.00	675	.00025
7.74	with	156	150	91	18.60	677	.01
9.60	against	148	140	315	59.98	984	.153
9.60	with	147	140	312	59.20	970	.143

TABLE II.

Economic Results.

Speed in Knots.	Horse Power.	Watts.	Radius of Action in Hours.	Radius of Action in Miles.	Expense per Trip.			Horse Power Hours.	Cost per Horse Power Hour in Marks.	Cost per Hour in Marks.
					Watts.	Kilowatt Hours.	Cost in Marks.			
10.00	59.30	43600	3	30	66500	200	20.00	178	.112	6.64
7.70	18.10	13450	13	100	19500	254	25.40	234	.109	1.97
4.90	5.30	4060	45	220	5660	254	25.40	238	.107	.57

Shamrock III.—Sir Thomas Lipton is building a third challenger for the America's cup, to be called *Shamrock III.* The yacht, which is to be of sloop rig, has been designed by Mr. William Fife, in consultation with Mr. Watson, the designer of the former *Shamrocks.*

Fuel Oil on the Pacific.—It is stated that over sixty steam vessels sailing from and about the bay of San Francisco are using crude oil exclusively for fuel. This number includes small tugs, river boats, ferryboats, coasting steamers, and transpacific ships.

Barges for Manila.—A fleet of steel barges for use in Manila harbor, for lightering freight between the shore and steamers in the port, is now in active service. The fleet includes nineteen barges in all, six of which are steam. The vessels are owned by the Philippine Transportation and Construction Company, and it is expected that their use will greatly reduce the cost and facilitate the handling of freight in the Philippines. The barges were built in Cleveland, O., and shipped from New York on the decks of large freighters.

THE STEAMER MIRA ASHORE ON CHEBOGUE POINT, NOVA SCOTIA.

A REMARKABLE CASE OF SALVING.

BY PROF. ALEX. J. MACLEAN.

The steel steamer *Mira,* having molded dimensions 350 feet by 46 feet 1-2 inch by 30 feet 1 inch, net tonnage 2,409 and gross tonnage 3,779, was built at Messrs. Swan and Hunter's shipyard at Wallsend-on-Tyne, England, in June, 1901. She was owned by the Dominion and Atlantic Coal Company, of Cape Breton Island, and classed 100 A1 at Lloyds.

The ship was especially designed as a collier, having a single set of triple-expansion engines right aft, capable of driving her at a speed of 10 knots per hour when fully loaded. There are large hatches, 19 by 16 feet, the sides of which are formed by continuous vertical plates running right fore and aft on the steel-plated deck, thus forming a strong longitudinal girder. One large hold box beam, midway between main water-tight bulkheads, supported in the center with an I stanchion and on each side of the same a circular stanchion, takes the place of web frames. The double bottom, 4 feet deep, with a capacity of 1,073 tons, has an inclined margin plate running from the flat of inner bottom to the upper turn of bilge, and is pierced by the channel frames and made water-tight with shoeing. This system of margin plate gives more capacity to the double bottom and allows cargo in bulk, such as coal, to slide down to the flat of inner bottom. There is also a large, deep tank amidships for 1,415 tons of water ballast or for cargo, the transverse bulkheads of which are well stiffened with wide fore-and-aft webs on the center line. All water-tight bulkheads are stiffened on one side only by channel bars. The bunkers, situated abreast the engine room and running up to the poop deck, have a total capacity of 262 tons.

The light draft of the *Mira,* no coal or fresh water on board, and boilers empty, is 4 feet forward and 14 feet aft, and on a mean load draft of 23 1-2 feet she carries a little over 6,000 tons dead weight. Her general fittings, such as winches, windlass, electric lighting, etc., are above the average for this class of vessel.

The *Mira* left Boston, Mass., on February 1, 1902, bound to Louisburg, Cape Breton Island, partially loaded with timber and machinery, having a crew of thirty-four men, all told. She at first met light easterly winds, but toward midnight a gale sprang up from E.S.E. with a heavy sea running and accompanied by snow squalls. The ship was steaming five knots an hour. These conditions prevailed when, at 1:45 A.M. of the 3d, a light was seen a little off the port bow. The master, being called, decided that it was Cape Sable Island light, and gave orders to steer directly away from the light and to increase the speed to ten knots an hour. The second mate, who was standing that watch, at 3:10 A.M. saw breakers ahead. He reversed the engine at full speed and ported his helm, but too late to prevent the ship stranding. The engines were kept working astern until the rudder post, fouling some rocks, broke, carrying with it the rudder, which struck the blades of the propeller and broke them off short. Then the engine was stopped.

Daylight revealed the fact that they were high and dry on Chebogue Point, Nova Scotia, lying parallel with the shore. The master had mistaken Cape Forchu light for that on Cape Sable Island, the two being similar in every respect. The crew saved their effects, and the ship was reported a total wreck. Mr. Eakin, the Lloyds' agent at Yarmouth, Nova Scotia, the nearest town to Chebogue Point, nine miles distant, then took charge of her and salved the cargo. Tenders for wrecking the steamer being asked for, that of Captain Reid,

of Sarnia, Ontario, was accepted. He contracted to deliver the ship at a dock either at Boston or Halifax for $50,000.

her afloat in a thick fog on Saturday night, August 2, but only succeeded in pulling her astern about 60 feet, and her stern out from the shore 30 feet, when

THE MIRA AT LOW TIDE, SHOWING THE LEDGE ON WHICH SHE STRANDED.

On surveying the hull it was found that not only had the rudder frame, rudder, and propeller blades been carried away, but the outer bottom was badly damaged, especially abreast No. 2 hold, where the center vertical keel, with the I stanchion above it, was bent up. All the seams and butts in way of the double bottom, both inside and out, were so severely strained that numerous rivets fell out.

There being large rocks abreast the ship fore and aft on the off-shore side, and the ship working badly as she lay, Captain Reid adopted the plan of digging a trench 400 feet long, 60 feet broad, and 4 feet deep on the in-shore side of the ship, and clearing away large ledges of rocks aft of the trench, then pushing the ship into this basin and floating her out stern first.

About the first of May he commenced to blast out with dynamite the slaty rock, which runs in vertical strata at this point, and, at the same time, with the use of an air compressor, calked the leaky seams and made temporary repairs along the outer and inner bottoms. The ship was kept steady at high water by building stone cribs under her bilges and allowing the water to rise inside of the hull. The trench being completed, steel-wire ropes attached to rocks in-shore were led to the winches on board, and four 100-ton hydraulic jacks were placed against the hull on the off-shore side. By these means she was hauled, on July 31, into the trench.

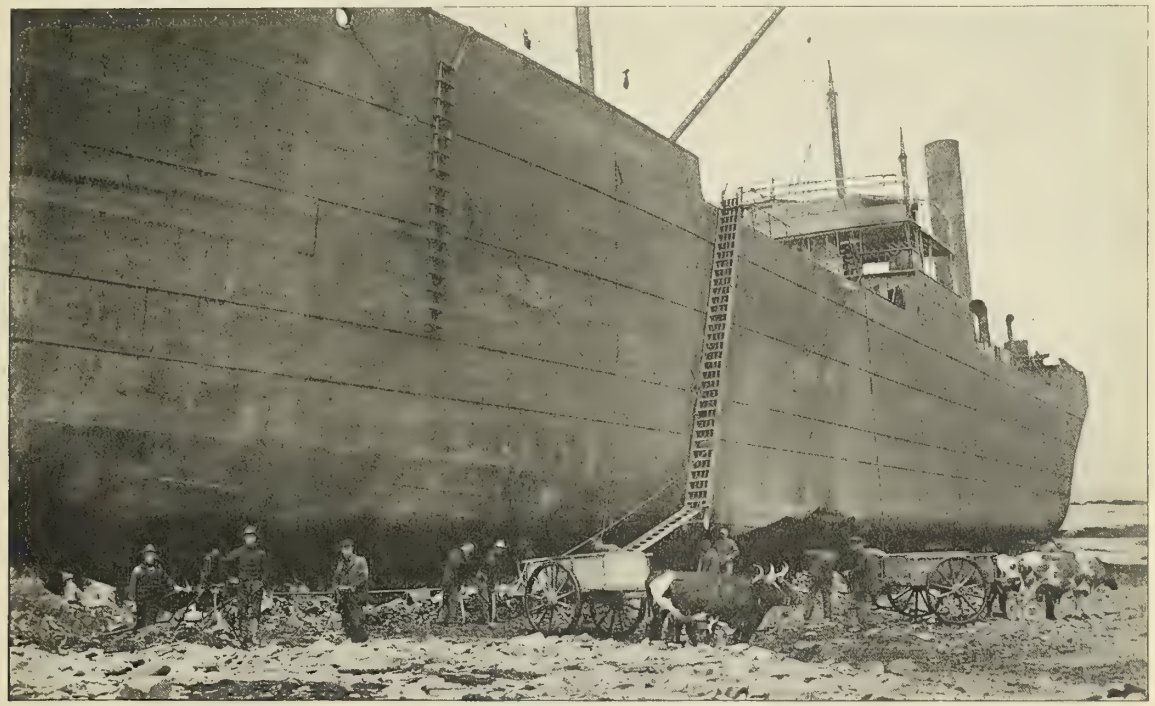
Braced wooden shores were substituted for the three stone cribs, and three extra pumps were put on board to be used with the ship's pumps in clearing the hold. When all was in readiness, with the aid of the deep-sea tug *Flushing*, Captain Reid made an attempt to get

she fouled the rock at the outside of the trench. This rock was cleared away. Then one end of a steel-wire

BROKEN STERN FRAME, RUDDER, AND PROPELLER.

hawser was made fast to a rock 100 yards right aft on the in-shore side, and the other attached to a fall leading to one of the ship's steam winches. The starboard an-

chor was placed on the off-shore or starboard side, amidships, in a hole dug in the rocks to receive the flukes, that she had a list to port during these trials, the cast-steel rudder post and rudder were picked up and placed

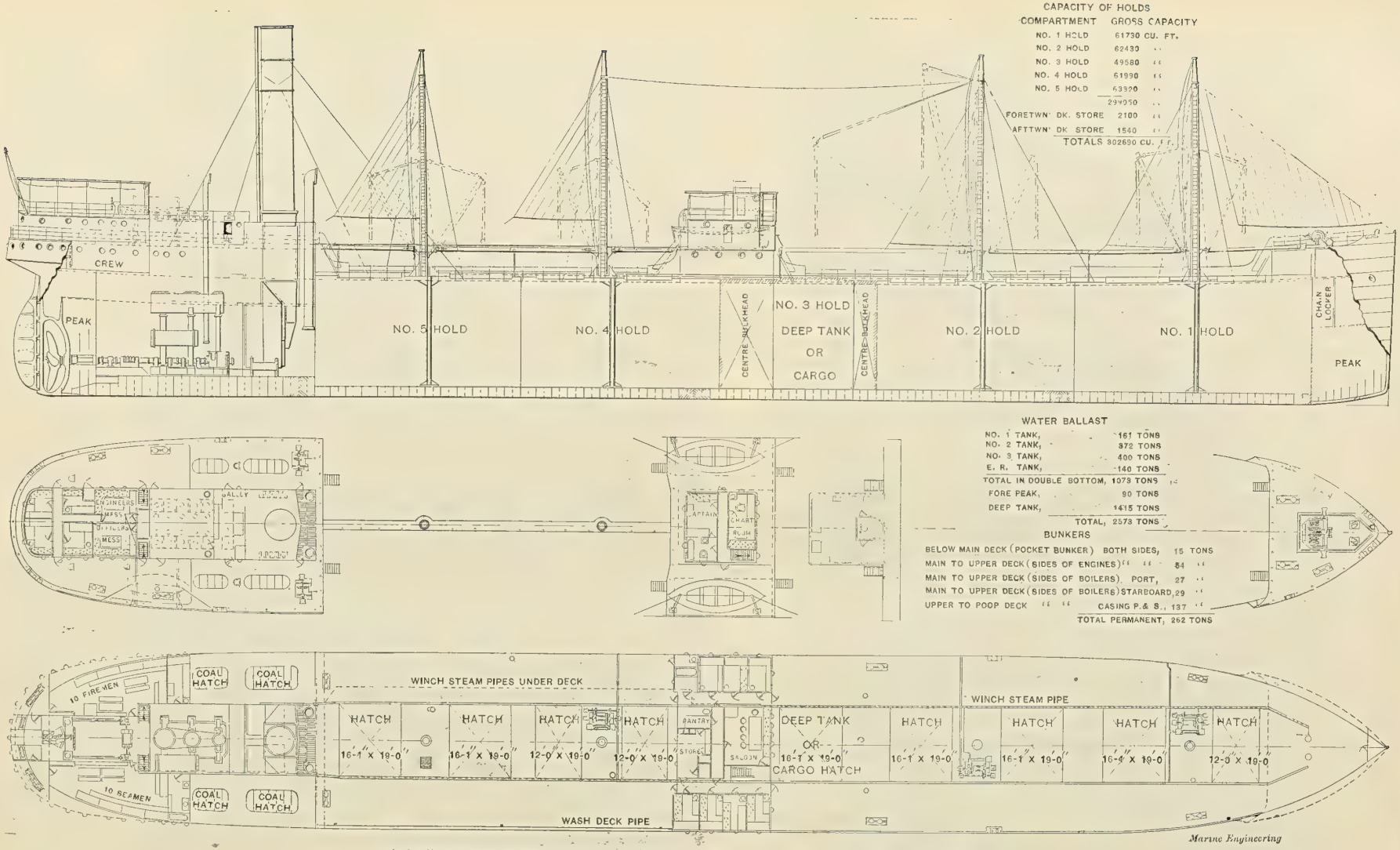


BLASTING AWAY THE ROCK ON THE IN-SHORE SIDE.

TRENCH FORMED ON IN-SHORE SIDE OF SHIP, INTO WHICH SHE WAS LAUNCHED.

and had a pull from the windlass. With the aid of the tug, another attempt to float the ship was made the next night, but was unsuccessful. More rock had to be blasted away from under her after bilges. It being noticed on the starboard side, and the large hole in the bottom was stopped up with a cotton and canvas mat.

The last and successful attempt was made on Wednesday night, the 20th of August. On this occasion the



ELEVATION AND DECK PLANS OF STEAMSHIP MIRA, BUILT BY SWAN AND HUNTER.

starboard anchor was taken 600 feet off-shore amidships. With the assistance of two small tugs from Yarmouth, her stern was pulled out, pivoting about her stern frame until she was at right angles with the shore line, when she slid off entirely, and, amid the whistles of the steamers and shouts from onlookers on shore, made her way without accident to the town of Yarmouth, from which harbor she has been towed to Halifax and there sold.

ELECTRIC IGNITION.—III.

BY DONALD M. BLISS.

The chief characteristic of a well-designed dynamo igniter is its greater output when compared with the magneto type, as stated in a previous paper. The only essential difference between the direct-current magneto and the dynamo is the manner by which the magnetic field is obtained.

In the magneto, permanent steel magnets are used: in the dynamo type the magnetic field is secured by powerful electric magnets composed of a soft-iron core and surrounded by a winding of insulated copper wire through which the current producing the magnetism flows. As this current is derived from the armature, it is evident that when the dynamo is not running there can be no current flowing and therefore no magnetism is produced.

A number of ingenious devices operating automatic clutch pulleys have been designed to secure this desirable result, and as dynamo igniters are quite largely used it may be of interest to describe one of the machines of this class:

One of the best known machines is the auto-sparker as in Fig. 1, which illustrates clearly the automatic device for securing a constant armature speed, though the speed of the engine driving the dynamo may vary through wide limits. The dynamo is fitted at its commutator end with a governor operating a rod which runs through the machine from end to end. When the speed of the shaft reaches the standard for which it is adjusted, the governor weights fly out, pushing the steel sleeve (6) out against the steel plate (5). This plate is mounted on one end of a lever pivoted at (9). This movement of the governor weights causes the other end of the lever at (7) to rise, and as this lever is connected to the body of the machine at (16), it raises that side of the dynamo up, since the entire machine is pivoted in its supporting frame at point (1). The dynamo pulley is in contact with the flywheel of the engine just above the point (10). It is this action of the governor which causes the pulley end to recede from the flywheel, thus reducing the speed, so that the action between the governor and spring serves to keep the armature running at a fairly constant speed, regardless of the diameter of the flywheel or variation in speed of the engine. The spring (12), which serves the double purpose of forcing the friction pulley against the flywheel and acting as a tension on the governor, may be adjusted by the thumbscrew (12).

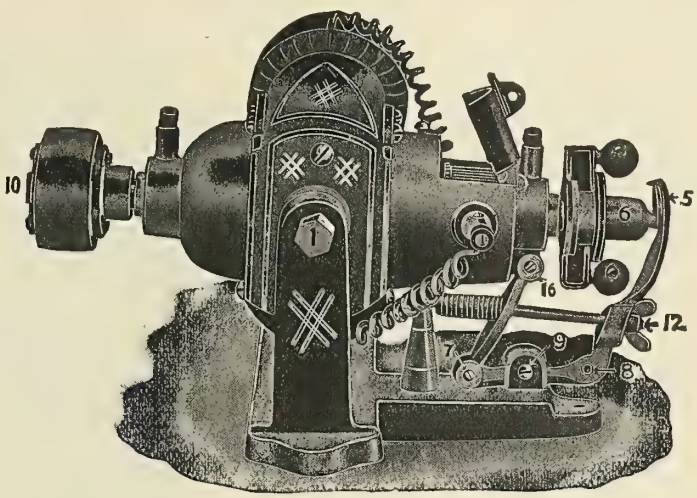


FIG. 1.

The magnetizing coil or field winding is permanently connected to the brush-holder terminals, so that whether the dynamo is supplying any current outside of itself or not, the field is kept magnetized as long as the armature is running at its proper speed. This arrangement is known as a shunt connection. In some cases an additional winding is wound on the field magnets, through which all the current generated by the armature flows. This is known as a compound winding and is well adapted for sparking dynamos.

For a given weight, an electro magnet can be made, which is much stronger than a permanent steel magnet—hence the greater output of the dynamo type. A magneto igniter weighing from 20 to 25 pounds may not deliver more than 2 amperes at 10 volts pressure, while a dynamo igniter of equal weight may easily give 6 amperes at 10 volts, or three times the output of the former.

A dynamo, whether shunt or compound wound, must be run at a fairly constant speed; for if the speed be much lower than the standard for which it is designed, the current and resulting magnetism will be so feeble that satisfactory sparks cannot be obtained. If run at a high speed so much current will be taken by the shunt coils that over-heating or even burn-outs may result.

By tightening or loosening this screw the speed of the auto-sparker may be increased or reduced, which in turn increases or diminishes the current and therefore the size of the spark.

The action of the governor may be reversed, if desirable, so as to raise the pulley up instead of down in cases where it is necessary to use the machine on top of a flywheel. This arrangement prevents any possibility of burn-out, and if the moving parts are kept

clean and receive ordinary attention this dynamo will give good service.

In a friction drive of this kind where frequent intermittent contact is maintained between the driving and the driven pulley, a rubber friction pulley is not desirable. Such a pulley should be made of the best compressed fibre.

Referring once more to the subject of brushes and commutators, it is even more essential to maintain absolute cleanliness and freedom from oil with the dynamo sparker than with the magneto, for in starting up the dynamo, where the initial magnetism is extremely weak, a very feeble current is generated during the first few hundred revolutions of the armature. A slight film of oil or dust on the commutator and brushes in such a case frequently offers so large a resistance that sufficient current to magnetize the field will not be produced. The brushes should be frequently examined and removed from the holder for cleaning.

Fig. 2 shows a new form of sparking dynamo designed by the writer, in which the necessity of an automatic speed-controlling device is overcome. This dynamo is not shunt wound, but has a single winding in the field through which the entire armature current flows. This is known as a series connection, and the wire composing the winding is sufficiently heavy so that it will carry a large variation in current without over-heating. To prevent the current leaving the field when the sparking contacts are separated, which would happen with an ordinary series-wound dynamo, a simple automatic switch enclosed in a water-proof iron case is connected to the dynamo in such a manner that when the sparking contacts are separated the dynamo current flows through a resistance coil, so that the current in the field is never broken. As soon as the contacts go together this auxiliary circuit is opened. No adjustment in the automatic switch is required or provided for, as its effective action depends entirely on the movement of the contacts in the engine cylinder. This dynamo will give a satisfactory sparking current at speeds ranging from 800 to 2,500 R. P. M. An ordinary friction pulley or belt drive may be used.

The dynamo is enclosed and dust-proof. The cap or cover over the commutator and brushes may be instantly removed, thus giving complete access to the working parts for cleaning and inspection without interfering with the running of the machine. The two dynamos here shown, or others of similar design and capacity, generate sufficient current to operate jump-spark coils with satisfactory results. The output of these machines may be as high as 6 amperes at 10 volts pressure at 1,800 to 2,000 R. P. M., so that when storage cells are used as an auxiliary for starting the engine these machines will easily give sufficient current for charging purposes.

In selecting a dynamo or magneto the following important requirements for securing satisfaction should be kept in mind:

The armatures, commutators, and brushes should be completely enclosed and water-proof; at the same time means should be provided for removing the covers, so as to give perfect access to its parts for cleaning and examination without stopping the dynamo or interfering with its operation.

The armature shaft should be of best grade of steel, and at least 3-8 or 1-2 inch in diameter at the pulley end to prevent springing or bending under excessive pressure.

The combination carbon and copper brush is preferable to the all-copper brush, for the reasons given in a previous paper, and these brushes should be of ample size and cover the commutator sufficiently to prevent any tendency to spark in ordinary working conditions. Machines having small, round pencil brushes, fitting loosely in a tube holder in such a manner that the brushes cannot be removed without stopping the machine, will not be found satisfactory.

Owing to the liability of moisture and corrosion, fibre or rubber insulation for the brush-carrying parts are not desirable. Mica insulation of sufficient thickness should be used.

The brush holder should be so arranged that the brush may be fed with a uniform pressure and good

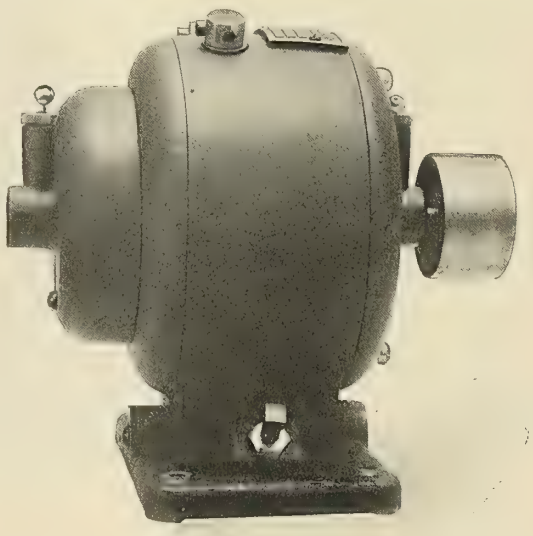


FIG. 2.

contact until it is practically worn out, and this feeding should be accomplished without changing the position of the brush on the commutator.

The armature bearings should be of the best phosphor-bronze or other equally good wearing material, and the means of lubrication, whether oil or grease is used, should be so arranged that there is no failure to feed so long as any lubricant is left in the cups. Many machines are defective in having no means for preventing the creeping of oil to the commutator and brushes. Such a condition will speedily result in destroying the good contact with the commutator and render failures of frequent occurrence.

In conclusion it may be stated that a thoroughly satisfactory igniting dynamo or magneto cannot be built or sold for a low price, and when an engine costing hundreds of dollars is put in commission it is poor policy to consider the matter of a few dollars in the selection of the igniter, upon which the satisfactory performance of the engine so largely depends.

THE NEED OF AN AMERICAN ISTHMIAN CANAL.

BY W. J. MANSON, ESQ.

The Pacific coast opponents of an Isthmian canal often urge as an argument that the remote isolation of the Pacific coast is an element of advantage in its favor, and that the construction of such canal will prove injurious to its many and varied industries. When it is remembered that railroads cannot and will not carry the heavy, cheap, and bulky productions of that prolific region, and that those productions must reach centers of population and of business at lowest rates of freight in order to leave any margin of profit to producers, this argument of the opponents to the canalization of the American Isthmus might be considered as sufficiently answered.

Not only do the great agricultural, lumbering, mining, quarrying, and fishing interests of that coast imperatively demand the early construction of such water highway of commerce, but for the manufacturing and shipbuilding interests of the Pacific coast such canal is an admitted necessity. The chief retardment to the shipbuilding interests of the Pacific coast, according to Mr. Geo. W. Dickie, of the Union Iron Works, in his article in the *Overland Monthly*, July, 1902, on the Building of Battleships, is "its remoteness from centers where the raw materials are produced, most of which must be transported 3,000 miles by rail or 14,000 miles by water."

That the Pacific coast offers many great advantages (not the least of which is its splendid working climate) for vast manufacturing enterprises will not be denied. When the raw material, those essentials, good coal and iron, can be laid down cheaply and expeditiously and without twice crossing the Equator upon a long, tempestuous, and dangerous voyage, the essential difficulty that has retarded the growth of Pacific coast manufactures of every class will be overcome, and mechanical operations of vast magnitude may be relied upon to give steady employment to a large and varied force of skilled artisans and mechanics

While an Isthmian canal will render our union closer and more permanent, and while this immediate and, as it may be termed, domestic advantage cannot be overestimated, yet from a strictly commercial standpoint such canal finds a greater argument for its construction in that it will bring the large centers of business and of population of the United States, where are concentrated its greatest energies, in close and cheap water communication with the Orient. Notwithstanding the fact that San Francisco is 9,000 miles nearer to Japan and China than is London, its share is inconsiderable in the vast foreign trade of those opulent countries. The centers of population and of industrial energy of America must be brought in close water communication with the Orient, in order that America may harvest her fair proportion of Oriental trade.

In 1894 the total foreign trade of China, Japan, Korea, and Siam aggregated $725,000,000 (silver). The share of China and Japan was $565,000,000, and in both China and Japan their imports exceeded their exports. In 1894 Japan imported from the United States $11,000,000 of merchandise, and in the same year Japan exported to the United States $43,000,000 of merchandise, or a balance *against us* of $32,000,000. In 1894 England bought from Japan $6,000,000 of merchandise and sold to Japan $42,000,000 of merchandise, a balance in England's favor of $36,000,000.

An examination of the trade relations of China with England and of China with America will tell the same story of American opportunity neglected.

But look for a moment at the decadence and well-nigh extinction of American shipping interests in Oriental ports teeming with an opulent foreign commerce. The story is best told by Hon. John M. Barrett, U. S. Minister to Siam, in his article in the *North American Review*, vol. 162, page 257:

"Shanghai is the most important port of China. In 1894, 2,844 merchant steamers, with a tonnage of 3,304,918, entered this port, but not one was American! Not one American trading steamer came to New Chwang out of 348; not one to Tientsin out of 645; not one to Chefoo out of 1,031; not one to Chinkiang out of 1,493; not one to Foochow out of 294; not one to Canton out of 2,250. Kind Amoy only breaks the mournful record, where four lone steamers out of 822 found a haven in her quiet waters. Hong-Kong, of course, is the terminal point of our few transpacific steamer lines, but that is not strictly a Chinese port."

If American shipping interests, if American mercantile interests, are to be put upon the soundest business basis; if America's mighty energies are to be placed where they can compete for this great industrial and commercial prize—Oriental trade—which has brought opulence to European countries not nearly so advantageously situated with reference to the Orient as America will be when we build and own an Isthmian canal; if the doctrine of the survival of the fittest is applicable to nations, then must America unite with a ship canal the oceans which embrace her coasts and keep the connecting waters bright with her passing keels.

The considerations of national unity and national defense are so potent, have been so frequently urged, and seem now to be so fully understood, that it should not be necessary to say anything upon these points, except, perhaps, that while America is so situated that she is the least likely of the nations of the earth to be engaged in war, yet, since in time of war America's possession of such canal is a strategic advantage in her favor, the canal itself will become the point and object of attack and is liable, notwithstanding treaties, to fall into the possession of that power which has the strongest navy. America, then, owes it to herself, to her trade extension, to her rightful dominance of the trade of the two great oceans embracing her coasts (which is certain and in the near future), to create and maintain a navy which in size and number of vessels, equipment, and armament shall be the most powerful in the world.

Now, briefly, as to the selection of a canal route. Until within a year or two past the only canal project before the American people was the Nicaragua project. The Panama canal has been exclusively in the hands of French concessionaires, and neither the American press nor the public has given to it the consideration which it deserves. Under these circumstances the in-

terest and sympathy of the American public in the Nicaragua enterprise was natural and to be expected.

The recent unanimous report of the Isthmian Canal Commission, commonly called the Walker Report, in favor of the Panama route has called to that route the critical attention of the public. This attention has been quickened, rather than diminished, by the recent legislation of Congress in passing what is known as the Spooner Amendment, by the terms of which the President of the United States is authorized to acquire, on behalf of the United States, for a sum not exceeding $40,000,000, all the property rights of every name and nature held by the New Panama Canal Company on the Isthmus, including the Panama Railroad, provided a satisfactory title is obtainable. If title to the Panama properties cannot be obtained within a reasonable time, the President is authorized to obtain by treaty with Costa Rica and Nicaragua perpetual control, on behalf of the United States, of the requisite strip of territory for the construction of a ship canal by way of what is known as the Nicaragua route.

The advantage which the Isthmian Canal Commission and Congress deem the Panama canal enterprise to possess over the Nicaragua project may be briefly summarized as follows:

1. The Panama canal is shorter, being only 49 miles as against 183 miles by way of Nicaragua.

2. The annual cost of maintenance of the Panama canal is $1,350,000 less than the annual cost of maintenance of the Nicaragua canal. This is an annual outlay. It represents, at Government rates, the interest on $65,000,000.

3. The waters of the Caribbean Sea in the vicinity of Greytown (the Atlantic terminus of the Nicaragua canal) are, during much of the year, rough and dangerous to shipping, and the weather tempestuous. Weather conditions and shore currents are believed to be more favorable to shipping in the vicinity of Colon.

4. Over 70 per cent. of the length of the Nicaragua canal, constituting the high level, is at an elevation of 110 feet above the level of the oceans. The water in this high level is retained by miles of high embankments. This long, high level is inherently dangerous in a country liable to the heaviest of tropical rains, and subject, on the east side of the lake, to an annual rainfall of between 300 and 400 inches. On the other hand, the Panama canal is susceptible of being made a sea-level canal, though the present plans for that structure contemplate a short, high level about 20 miles in length, at an elevation of about 89 feet above sea level. The average annual rainfall at Panama is about 130 inches. On the Nicaragua canal the ascent to the high level is made by four locks on the Atlantic side and four on the Pacific side, or eight locks in all. On the Panama canal the ascent to the high level is made by two locks on the Atlantic side and three on the Pacific side, or five in all.

5. The cost of completing the Panama canal is placed by the Commission at $144,233,358, to which sum must be added the cost of the Colombian concessions to the United States, probably $7,000,000, and the price to be paid the French companies, $40,000,000.

The cost of constructing the Nicaragua canal is estimated by the Commission at $189,764,062, to which sum must be added the cost of concessions from Nicaragua and Costa Rica, and the acquisition of the right of way by our Government from private parties in possession.

6. The Panama route traverses a country well understood and thoroughly mapped. No unknown difficulties are involved. The engineering problems which arise are known, and none of them are doubtful or difficult, except, perhaps, the dam at Bohio. The Nicaragua route passes through an unsettled and undeveloped wilderness. Engineers are uncertain as to many of the problems presented, and the estimated cost will be considered by conservative men as only an intelligent guess.

7. The Panama route possesses fair harbors at both termini. None exists at Nicaragua, and the construction of a harbor at the Atlantic terminus of the canal is a difficult and involved problem.

8. The Panama route possesses a modern and well-equipped railroad following closely the line of the canal. This greatly facilitates the work of construction, to say nothing of its being a source of revenue.

9. The Commission seems to consider climatic conditions somewhat worse at Panama, though the differences are slight. Efficient sanitary supervision of camps, an adequate sewerage system, a good water supply, are indispensable hygienic precautions which will greatly improve health conditions along either route.

10. The curvature of the Nicaragua route is excessive as to the total number of degrees of curvature, the number of miles of curvature, and the sharpness of the proposed curves. When we consider that during at least half of the year a strong breeze of 16 knots blows here across the Isthmus, and athwart the proposed canal at various points, it can be seen that navigation of the canal would be seriously impaired. In the opinion of the most informed and practical navigators, such as Captain Watt, of the *Campania;* Captain Cameron, of the *Oceanic;* Captain Jamison, of the *St. Paul;* Captain Richter, of the *Kronprins Wilhelm;* Captain Hoegemann, of the *Kaiser Wilhelm der Grosse,* and numerous others equally competent to speak upon this point, an average-size steamer, say 450 feet in length and drawing 25 feet of water, could not pass through the Nicaragua canal with her own steam, but would require from two to five tugs. Considering the curvature, the breeze, and the width of the canal, these practical navigators, who have navigated the Suez, the Manchester, and other canals, say that were the Nicaragua canal built a steamer might get athwart the canal, with her bow on one bank and her stern on the other, blocking traffic indefinitely. Each of these captains and practical seamen (some eighty odd in all) says that were both canals constructed, and were he sailing an average-size steamer from New York to San Francisco, he would take the Panama route and he would make at least as good time (most say better time) by that route, though the distance from New York to San Francisco is 435 miles greater by way of Panama than by way of Nicaragua. The absence of winds at Panama is looked upon by these captains as a most favorable circumstance for inland navigation. On the other hand, they say that the prevalence of winds at Nicaragua not only delays inland navigation, both of steamers and sailing vessels, but is an element of considerable danger.

It may be concluded, therefore, from the practical standpoint of navigation and operation of the canal

after it is built, that the Nicaragua canal would be an inadequate device for the passage of sailing vessels or steamers from sea to sea. This point is clearly and convincingly made by Senator Hanna in his speech in the Senate (*Congressional Record*, June 9, 1902, page 6873).

A good deal has been said about the Nicaragua canal being better situated and more practicable for our sailing tonnage, constituting, it is claimed, nearly five-eighths of our total tonnage, than would be the Panama canal. These general statements are based solely upon the prevalence of wind conditions at Nicaragua and calm conditions at Panama. Nicaragua is without, or on the northern edge of, the equatorial calm belt, or the region called by sailors the "doldrums." Panama is well within the region of the "doldrums." It is inferred from these conditions that the Nicaragua route is suited to sailing vessels and the Panama route unsuited to them. From the point of view of practical operation of the canal after it is built, it is apparent that the Nicaragua canal could not be used by sailing ships except at immense expense for towage, and without considerable delay and danger, not only to the ship and cargo, but to all traffic, by reason of such vessel getting athwart the canal and aground on both banks.

The Canal Commission is of the opinion that steamers are now so rapidly replacing sailing vessels that by the time an Isthmian waterway is completed only a very small portion of the tonnage under the flag of the United States will consist of sailing vessels, and the Commission is of the further opinion that sailing vessels will probably be unable to compete with steamers by either route.

This does not mean the elimination of sailing vessels from ocean commerce. The field of their employment will simply be restricted. For portions of our coastwise trade there will always be a demand for sailing vessels.

The effect of the canal upon railroad traffic, particularly transcontinental traffic, is a question to which the writer, for ten years past, has given close consideration. Railroads and canals are supported by the carriage of different species of merchandise. They supplement each other. The carriage of passengers, mails, expressage, quick and light freights, constitutes the natural and legitimate business of the railway. Heavy, cheap, and bulky productions must take the water route (or remain uncarried) in order that some margin of profit may be left to producers.

Do the Great Lakes and the Erie canal impair the efficiency or the dividends of the numerous trunk lines of railway which parallel that splendid waterway? This question need only be asked to answer that those vast systems of railway derive their revenue from the *volume* of the business which that water highway of commerce makes possible, and not from heavy freight charges on those bulky productions which the genius and spirit of the age demand shall be carried cheaply.

An Isthmian canal will enhance the business of railways, even of transcontinental railways. The interior of our country will be inhabited and built up. Where now are barren wastes will be fertile plains and prosperous cities, made prosperous because some margin of profit will be left to producers, and railways will prosper where producers, under a wise and comprehensive legislative policy, are permitted to prosper.

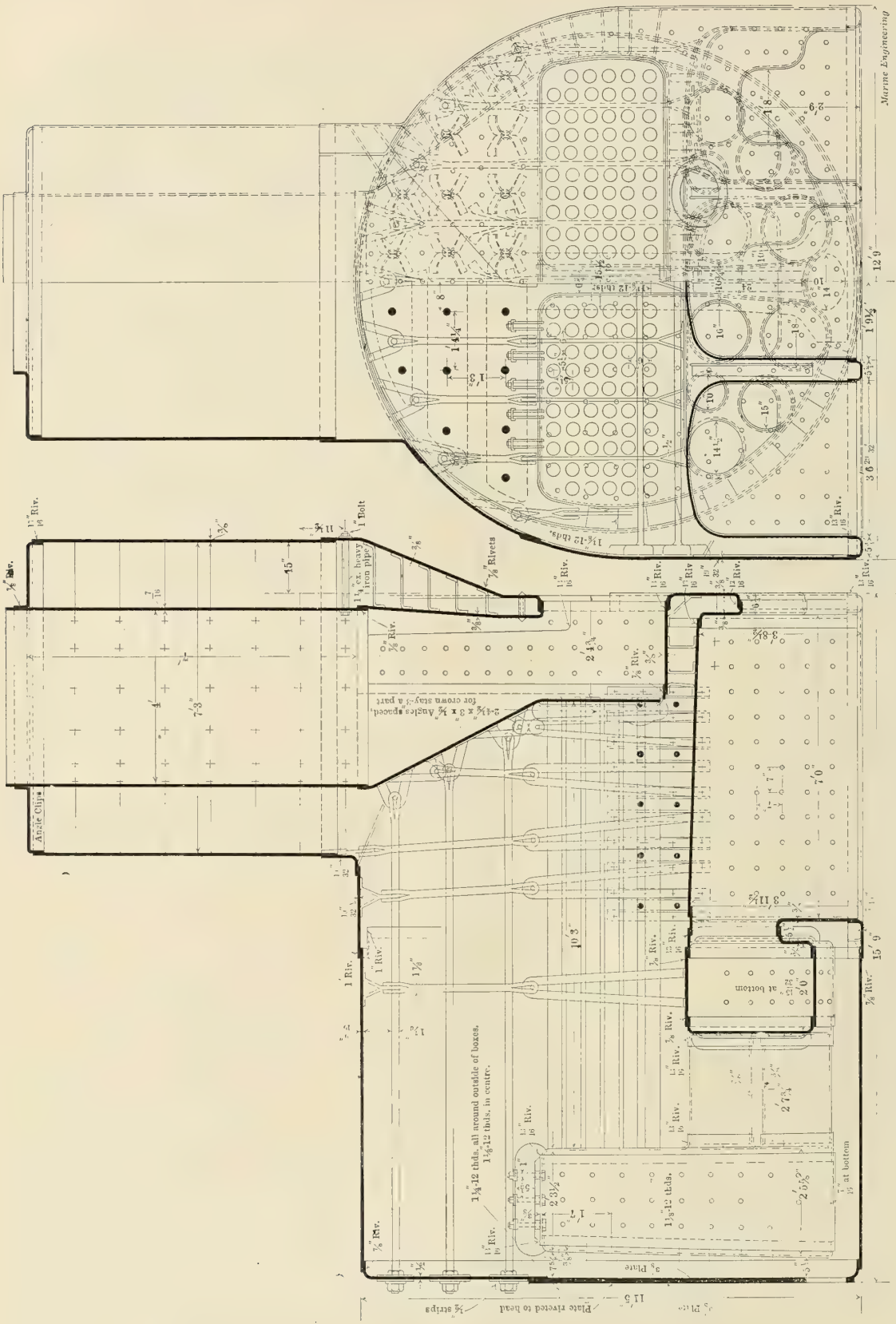
A Modern Flue and Return Tubular Boiler.

In these days of water-tube boilers and Scotch boilers designed for high pressures, a boiler of the old-style flue and return tubular type seems almost a step in a backward direction. The boiler shown in the accompanying engraving has been but recently completed in the boiler shops at the Mare Island Navy Yard and installed on board the U. S. revenue cutter *Perry*. This vessel, although built as late as 1884, is fitted with a simple engine, the cylinder for which is 38 inches in diameter by 40 inches stroke. As the condition of the hull was not such as to warrant the expense of fitting a new multiple-expansion engine, it was decided to put in a flue and return tubular boiler similar in most respects to the old boiler. In the limited space available it was found impossible to put in a Scotch boiler which would provide sufficient grate area for a simple engine of this size. In this boiler a grate area of 73.5 square feet was obtained, which has proved to be ample to develop approximately 400 horse power with the simple cylinder engine, cutting off at four-tenths of the stroke, the working pressure being 60 pounds per square inch. For a large grate area in proportion to the space occupied, and for a low working pressure, it would be difficult to design a boiler more efficient than the type here illustrated. It would surprise many to learn how many boilers of this type are now in use on vessels in American waters, principally engaged in harbor and river traffic. As a rule these boilers are long-lived, the old boiler on this vessel having lasted 18 years. This longevity is probably due to the low pressures of steam used, accessibility for cleaning and repairs, and good circulation. One of the weak points about this design is the rapid deterioration usually met with in the bottoms of the water legs, owing to poor circulation and inaccessibility for cleaning. This can be in a measure prevented by filling the legs with cement to a depth of 10 or 12 inches above the bottom, or up to a height of the level of the grate. The principal dimensions of the boiler in question are as follows:

Length on base	15 ft. 9 in.
Length over all, including steam chimney	17 ft. 0 in.
Width of boiler front	12 ft. 9 in.
Diameter of cylindrical shell	11 ft. 6 in.
Height of boiler from bottom of legs to top of shell	11 ft. 6 in.
Height of steam chimney above shell of boiler	7 ft. 0 in.
Diameter of steam chimney	7 ft. 3 in.

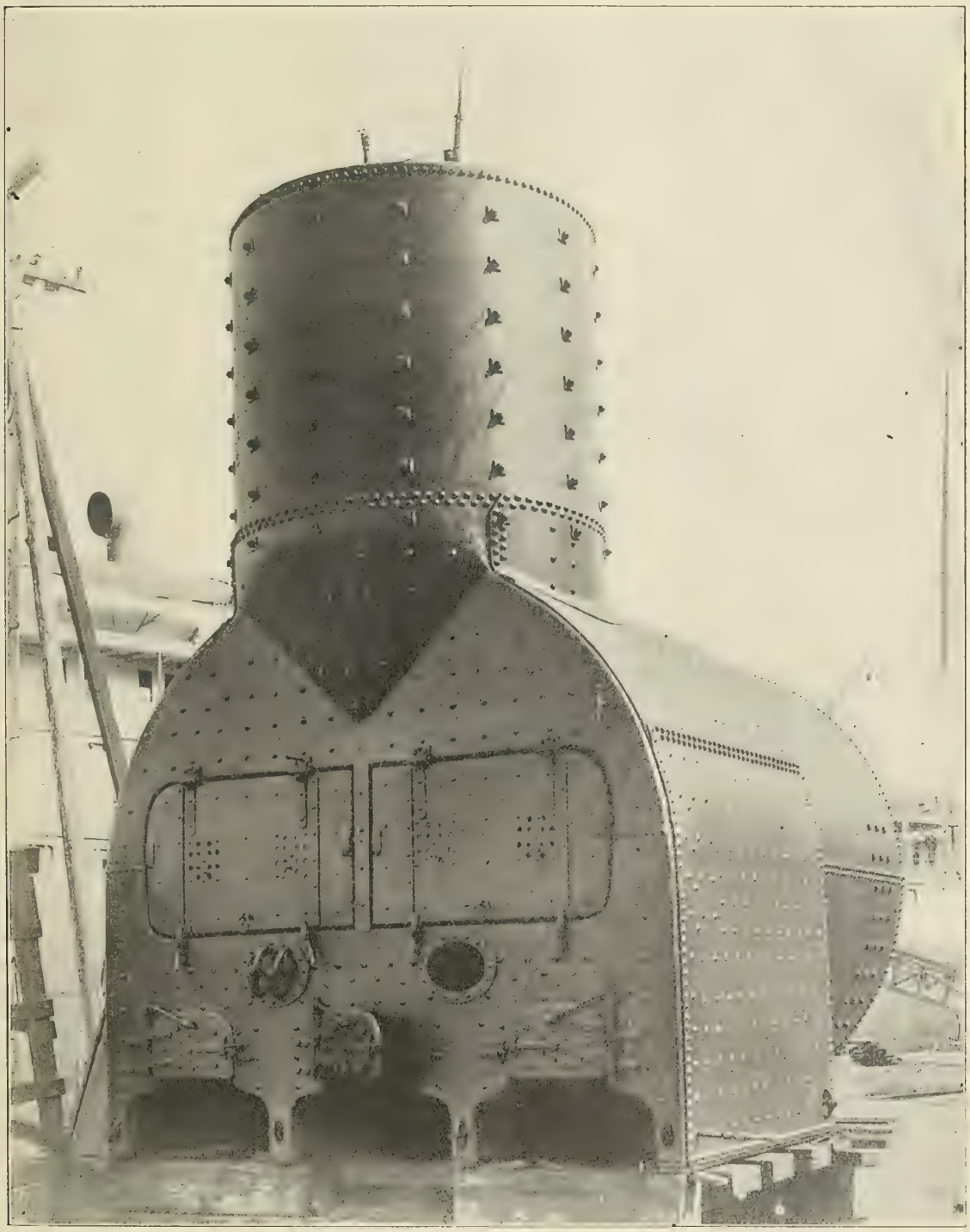
It will be seen from the cut that the plates were worked as large as possible, thus avoiding to a considerable extent the numerous riveted joints necessary for this type of boiler as built in the earlier days. The thickness of the cylindrical shell is 9-16 inch; of the front shell and side sheets, 19-32 inch; of the furnaces and steam chimney shell, 3-8 inch. Double riveting is used in all parts of the shell, the rivets being 7-8 inch and 1 inch in diameter.

There are 130 4-inch tubes, No. 10 B. W. G. They are made of the best quality of seamless drawn steel, and were each tested to a hydrostatic pressure of 500 pounds per square inch.



WORKING DRAWINGS OF THE FLUE AND RETURN TUBULAR BOILER OF U. S. REVENUE CUTTER PERRY.

All seams on the boiler were thoroughly calked both on the outside and inside. In fact, the workmanship throughout is of the highest quality and reflects credit upon the workmen of the Mare Island Navy Yard.



FLUE AND RETURN TUBULAR BOILER OF THE PERRY.

Durbin Floating Dock.—A floating dock, to be used at Durbin, South Africa, was recently launched at Swan and Hunter's shipyard. The dock has a lifting capacity of 4,500 tons, and is made up of five members—two side walls and three pontoons. The latter are connected to the side walls by movable joints, so that any one of the pontoons may be lifted by the dock for repairs. There are two complete sets of pumping engines—one in each wall.

GAS ENGINES AND THEIR TROUBLES.—V.

BY E. W. ROBERTS.

Methods of starting a gasoline engine are the same in principle for all types and classes. There are slight variations according to the character of the vaporizer and the igniting device, and sometimes in large engines what is known as a starter is employed.

It should be borne in mind that to start a gas engine successfully an explosion must be secured in the cylinder at the proper time to drive the crank in the running direction, and that the explosion must be of sufficient force to take the engine through at least another cycle, that is, with sufficient force to bring it over the center before the ensuing explosion has gained enough force to drive the engine backward. In engines where the lead of the igniter may be decreased to zero or made negative, there will be no danger of an explosion occurring before the end of the compression stroke, and consequently of driving the engine backward. Where, however, the igniter has a constant lead the possibility of securing too early an explosion should always be borne in mind. If the first explosion has sufficient force, the chance of the piston being retarded by the second explosion is very slight.

In the two-cycle engine the retarding impulse will quite frequently start the engine backward; and this is a point which the operator of a two-cycle should never forget, otherwise a serious accident might result. Occasionally a two-cycle engine will slow down from lack of proper fuel adjustment, and by the time the operator has opened the needle valve the proper amount the engine will take an impulse too early in the stroke for the speed at which it is running, and reverse. In a two-cycle engine having a constant lead or one in which the lead cannot be changed for starting, the best plan upon feeling the compression is to bring the starting crank around quickly, so that the momentum will carry the crank over the center in spite of the resistance due to the back pressure caused by the early ignition.

Quite a neat little trick in starting a two-cycle engine is to rock the flywheel back and forth two or three times, so as to pump the crank case full of mixture, and then give it a sharp jerk in a reverse direction. The flywheel should be pulled just hard enough to make the igniter snap, and this will give an explosion before the piston has reached the top of the stroke, starting the engine ahead and giving it sufficient impulse to take up the next cycle. It will be understood that this can be done only with such engines as have an igniter which will work equally well when rotated in either direction.

Engines having cylinders of four inches diameter or larger, especially when they are operated at high compressions, usually have a relief cock. This relief cock allows a portion of the mixture to escape, thus reducing the compression pressure and making it easier to turn the engine over. When starting, besides opening the relief cock, engines with variable-lead igniters should be set to ignite no sooner than at the end of the stroke. The relief cock should of course be closed and the lead of the igniter increased so soon as the engine is under way.

It is an excellent plan to train one's self to a regular order of procedure both for stopping and starting a gasoline engine. For instance, in starting the engine, first prime it and allow the priming charge to evaporate while attending to other necessary preliminaries. Then fill all oil and grease cups, no matter if they are nearly full already. Next test the electric circuit and see that it is in working order; see that the electric switch is closed and that the cocks to the pump are open, so that the water may be pumped either from the bilge or from the sea as circumstances demand. Then open the gasoline needle valve on the vaporizer a trifle more, if anything, than it should be when running. The relief cock being open and the igniter set at zero lead, give the crank one or two quick turns, never more than four or five, and the engine should start. Immediately close the compression cock, advance the igniter, and turn on the cylinder oil. If the engine does not start with four or five turns, don't break your back by continued cranking, but turn off the vaporizer and see what the matter is. A two-cycle engine should always get an explosion in two to three turns of the crank and a four-cycle engine in four to six turns.

In stopping the engine, first turn off the cylinder oiler about ten minutes beforehand, so as to allow the surplus oil to be carried out with the exhaust, and thus avoid clogging from oil remaining in the cylinder. Then open the igniter switch and shut off the gasoline at the vaporizer just as the engine stops. This will leave an unconsumed mixture in the crank case or the cylinder, according to the type of engine, and make it easier to start the next time. These instructions for starting and stopping will of course be modified according as the engine has special attachments for making one or more of the operations unnecessary. Sometimes the engine will start hard in cold weather or even when the humidity of the atmosphere is very great. Filling the water jacket with hot water and warming the vaporizer by the application of artificial heat will often help in this regard. Never use a direct flame, especially on the vaporizer, as a fire might ensue. An attachment for heating the ingoing air or a portion of it by drawing the fresh air from a small drum surrounding the exhaust pipe will sometimes be found of assistance, and especially so in moist weather. It is a wise precaution, when stopping for any length of time, to see that the bilge cock and the sea cock are not both open. Should they be left open the water may siphon up through the sea inlet and down through the bilge pipe, flooding the boat.

Pounding in a gas engine may be due to a tight piston, to loose bearings, or to premature ignitions. A tight piston may be due to the unequal expansion of the metals in the piston and in the cylinder wall. This is likely to occur only in a new engine where the piston has not been given freedom enough in the cylinder. Poor water circulation may cause over-heating and poor lubrication may permit too much friction, either one allowing the piston to cut and stick. The remedy for loose bearings is obviously to tighten them up. To tighten up a loose bearing and yet not have it too tight, turn the screws up snug and then turn them back from an eighth to a quarter of a turn. If the bearings are too tight, it is easily discovered by turning the flywheel when the piston is at the end of the out-stroke. Premature ignitions may be produced by other causes than too much lead of the igniter. Such ignitions may be

spontaneous, being produced by the mixture reaching the ignition temperature before the igniter operates. Premature ignitions are quite often due to over-heated air, and it is a good plan to run the engine with as cold air as circumstances will allow. Thin projections in the compression space, such as fins of metal, small flakes of carbon, or extremely light igniter parts, may become over-heated and fire the charge in the same manner as an ignition tube.

Muffler explosions, while themselves annoying, are not dangerous unless the muffler is too light in construction. A muffler should always be designed to withstand a pressure of one hundred pounds to the square inch, as this is the maximum pressure that may be obtained with the explosive mixture at atmospheric pressure. These explosions are caused invariably by unburned mixture finding its way into the muffler. Unburned fuel may reach the muffler through a leaky exhaust valve, or, in the regular operation of the engine, by charges that have failed to ignite in the cylinder. Mixtures that are too rich in fuel will allow an unburned portion to reach the muffler and mix with air that may find its way in from the atmosphere.

Crank-case explosions in a two-cycle engine are due either to a weak mixture or to delayed ignition. A weak mixture burns slowly and there is too much flame remaining at the end of the stroke for it all to get out of the exhaust port before the fresh charge reaches it in the crank case. Late ignitions have the same effect. The remedies are to increase the proportion of fuel and to increase the lead of the igniter. Sometimes, in a small boat, the engine may be running all right when the operator is near by it and crank-case explosions will begin as soon as he passes to the bow. This is due to the change in level of the boat and may be avoided by giving the needle valve a slightly increased opening just before starting forward.

Quite often an engine that has been running very nicely may be left for a short time after it has been stopped and will refuse to start when next called upon. This refers to a two-cycle engine and may generally be traced to a flooded crank case. The remedy is to clear the crank case either by turning the engine over and pumping it out, if there is not much gasoline in it, or by draining it through a small pet cock which is usually placed at the bottom of the case. If there is no pet cock it may be necessary to let the engine stand for a while and allow the gasoline to evaporate until the crank case is clear. If the crank case is badly flooded the only remedy is to remove the hand-hole plate and bail it out.

Smoke issuing from the exhaust is usually due to an excess of cylinder oil. Excessive fuel will occasionally cause a slight smoke, as will a fuel of a specific gravity greater than that ordinarily employed; as, for instance, if kerosene were mixed with the gasoline. Excess of fuel in the mixture may generally be discovered by the odor and by a stinging sensation in the eyes when the face is held over the exhaust.

When an engine falls off in power and yet takes its impulses regularly, the fuel mixture may not be right, and the gasoline feed should be altered a little at a time until a point is found at which the engine will give its highest speed. A late exhaust caused by slipping of the exhaust cam, a weak exhaust valve spring, or a too stiff spring on a suction inlet valve may also produce the same result. Quite often the exhaust passages become choked with carbon or the engine may lose compression. Loss of compression may be due to the piston rings becoming fast in their grooves or to a leaky cylinder-head gasket. Water finding its way from the crank case into the cylinder will dampen the explosion and occasionally short-circuit the igniter, resulting, of course, in a loss of power.

It is the custom on all gas engines to use asbestos for packing the joints. This should be about one thirty-second of an inch thick and should be carefully cut so as not to have a break through the gasket. Where the packing surfaces are narrow, dressing the metal with orange shellac will usually insure a tight joint. A plan that has been quite successfully employed is to chalk one face of the joint and saturate the gasket with silicate of soda. Several hours should be allowed for the silicate to harden, which it should do when in place on the joint, and with the surfaces tightly bolted together. This plan allows the gasket to be used a second time, as it will stick to the unchalked surface and break clean from the chalked face. An asbestos joint will be much tighter when made between two comparatively rough surfaces than when the faces of the joint are smooth, as the small ridges will help to hold the gasket in place.

For regrinding the valves of a four-cycle engine, pumice powder or grindstone grit are usually considered superior to emery, as they are not so likely to find their way into the wearing surfaces and produce cutting. A leaky valve stem should be remedied either by putting in a new valve or by boring out and bushing the bearing. When the valves stick and remain open, the spring may not be strong enough to return them to their seats or the valve stem may be coated with carbon or possibly bent. For lubricating valve stems kerosene is a much better lubricant than machine or cylinder oil.

(To be continued.)

Steamer Thomas Adams.—On June 19 the steamer *Thomas Adams* was launched from the Craig Shipbuilding Company, Toledo, O. The dimensions are as follows: Length, 385 feet; beam, 50 feet; depth, molded, 28 feet. The engine has cylinders 21, 34, and 57 inches in diameter by 40 inches stroke. There are two Scotch boilers 14 feet in diameter and 12 feet long and built for a working pressure of 180 pounds. The vessel is built for the Adams Transportation Company, Detroit, Mich.

Steamer Norumbega.—The steamer *Norumbega* was recently launched in the yard of Kelly and Spear, Bath, Me., at the order of the Maine Central R. R., for service between Bar Harbor and Frenchman's Bay. The dimensions are: Length, 157 feet; breadth, 30 feet 6 inches; depth, 10 feet 6 inches. There are two engines, built by the Bath Iron Works, of the three-cylinder, triple-expansion type, with cylinders 10, 15½, and 26 inches in diameter by 15 inches stroke. The revolutions in service are estimated to be 220 a minute. There are two Almy watertube boilers giving 88 square feet of grate surface and 2,720 feet of heating surface, and independent air and circulating pumps.

ELECTRICAL STEERING APPARATUS FOR SHIPS.

BY GEO. MCQUILKIN, JR., E. E.

To understand the operation of this apparatus it is necessary to clearly investigate the conditions under which the motive power for a steering gear is required to run.

If a steam engine is used, the admission valve of the engine is operated by a wire rope, shaft, or hydraulic telemotor from the chart house, conning tower, or the bridges, by the steering wheel at those points.

The steering wheel is mounted on a pedestal carrying an index pointer operated by the gearing connecting with the steering wheel, so that when the steering wheel is moved this index indicates the position it is desired to turn the rudder and is read in degrees port and starboard.

Assume that the rudder is in a fore-and-aft position; that is, its vertical plane coincides with the center line of the ship. In this position the index needle will be at the zero point, and if the top of the hand steering wheel is turned to port the index needle will move to starboard, and the rudder will move to starboard the same number of degrees that the index needle indicates. Similarly, for an opposite movement of the steering wheel, the index needle and rudder will move in the opposite direction, that is, to port.

During the turning of the steering wheel the wire rope, shaft, or telemotor, as the case may be, has opened the steam-admission valve on the engine in the direction necessary to admit steam to the proper side of the piston to cause the engine to rotate and turn the rudder in the direction as indicated by the index. As the engine rotates, it gradually moves the admission valve to its closed position, and this gear is designed so that when the rudder is at the required angle the admission is entirely closed. The engine then stops and will not move until the steering wheel is again turned. But the mechanism is arranged so that the steering wheel remains at the position placed and is not returned except at the will of the operator.

It will be seen that with this means a nicety of adjustment and a frequency of attention to the reciprocating parts are necessary, the engine under certain conditions being heavily loaded and at high speeds. Since only one steering engine is installed, its importance cannot be overestimated, even though the auxiliary manual steering wheels are installed in conjunction. An instance of this is the bursting of a steam pipe in the steering-engine compartment, and the impossibility of making necessary repairs and operating the auxiliary wheels at the same time.

In a twin-screw ship this would be overcome by the engines being used alternately, but in a single-screw ship sails would have to be resorted to.

The greatest power is required, when the ship is under way, to move the rudder from its center position to hard over, for then the force of the moving water projected by the screw against the rudder has to be overcome; while but little power is required to move the rudder from the hard-over position to its center position, for then the force of the moving water assists the rudder in that direction.

It is obvious, in the latter condition, that if the engine has the same valve opening as when it moved the rudder from the center to hard-over position, the load having been greatly reduced due to the assistance of the moving water, the engine will tend to speed up, and a continuance of this class of service may bring severe strains on the engine and its mechanism. If, furthermore, the engine is located near the rudder post, it will be necessary to carry the steam and exhaust pipes through bulkheads, cargo spaces, and shaft alleys, the latter being ordinarily of small proportions, and in the event of an accident to the main engine shafting they might interfere with making repairs.

It is not intended here to give the impression that electrical steering apparatus will be a remedy for all the above faults, but to make a comparison of the two systems. The electrical steering gear has to perform service identical to that of the steam steering gear. It works on the principle of a Wheatstone bridge (Fig. 1).

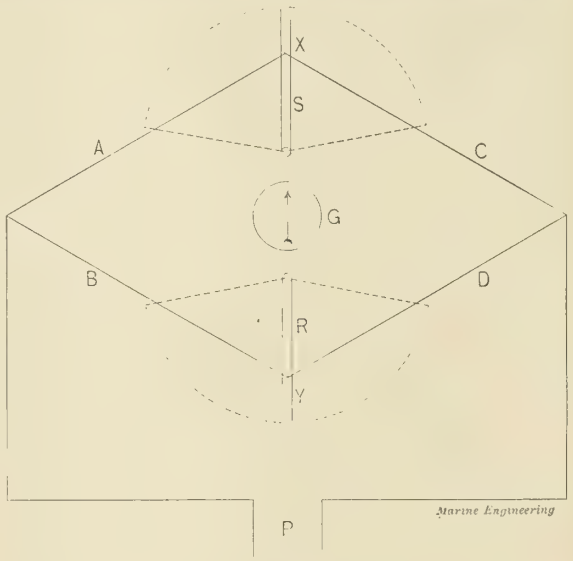


FIG. 1.

A, *B*, *C*, and *D* are four arms of wire of equal resistance values. At the junction of *A* to *C* and *B* to *D* is an instrument, *G*, for indicating the flow and direction of current that may pass over *XY*.

At the junction of *C* to *D* and *A* to *B* current is supplied, and if the ratio of *A* to *C* equals that of *B* to *D* in resistance value, there will be no difference of pressure (potential) at *XY*, and the instrument *G* will not indicate, and the system is said to be in "balance." But if the value of *A* is changed, this makes the arms of unequal relative value, and the system is out of "balance," and the instrument *G* will indicate, the direction of indication depending on the value of *A* being made greater or less than originally.

If the value of *A* is made greater, then it will oppose the flow of the current more than it did before, and the current will flow in a greater proportion in *B B;* and since the value of *C* was not changed, a part will also flow from *B* to *Y*, through *G*, and cause *G* to deflect. On the other hand, if *A* were made less, then relatively more current will flow over *A C*, and, since the value of *D* has remained the same, a portion will flow from *A* to

X, through *G*, to *Y* to *D*, and instrument *G* will deflect in an opposite direction to that when the value of *A* was increased, because the current has entered *G* in an opposite direction. In the first case the current flowed from *B* to *Y*, through *G*, to *X* to *C*, and in the second case it flowed from *A* to *X*, through *G*, to *Y* to *D*. If the value of *A* were decreased, assume one-half, the "balance" of the system could have been settled by decreasing *B* one-half, for then the two arms would again have their values in the same ratio to *C* and *D*. Likewise if the value of *B* were disturbed, a "balance" could be obtained by disturbing *A* in equal proportion, and similarly for *C* or *D*. If a mechanism were connected to the needle at *G*, so that when the value of *A* or *C* were disturbed the deflection of the needle would disturb the value of *B* or *D* respectively, then the system would be automatically *"balanced."*

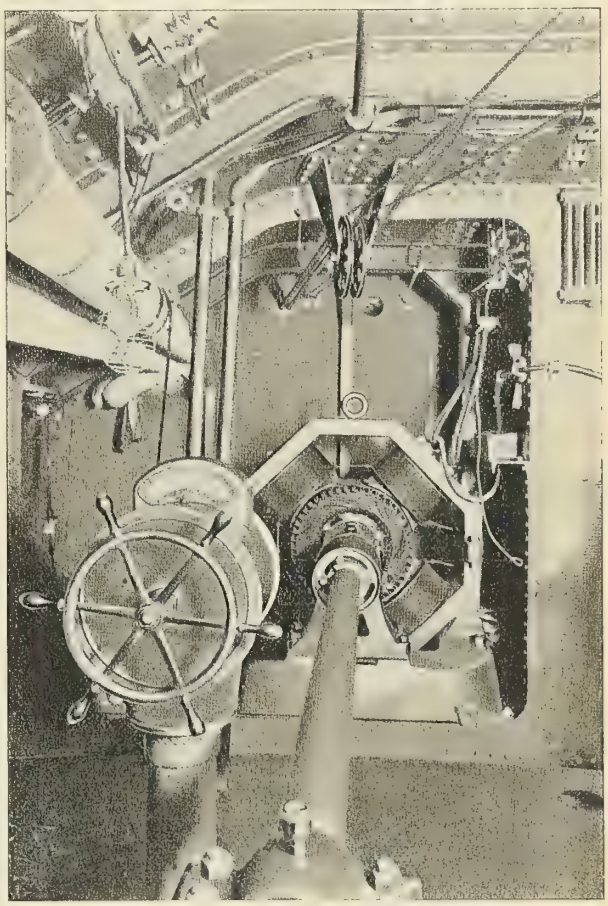
To apply the above principle to the practical operation of a steering gear the instrument *G* is replaced by a motor *M*, reversible as to direction of rotation and operating the gearing to the rudder and the contact arm *R*, over *B* and *D*, so that current flowing through the "balance" wire *X Y* will operate the motor to move the contact arm *R* and automatically "balance" the system, decreasing or increasing *B* or *D* in exact proportion to the decrease or increase of *A* or *C* respectively by their contact arm *S* (which is operated by the hand steering wheel, Fig. 2), so that when the two contact arms *R* and *S* correspond no current will flow and motor will stop. This would be a simple arrangement but for the heavy currents that would have to be carried in the resistance arms, causing excessive sparking and consequent deterioration at the contacts. This and many other disadvantages have been overcome in the following manner:

An engine drives a dynamo at constant speed. The dynamo armature current is conducted direct to the armature of the steering motor, whose fields are constantly excited (Fig. 2). The dynamo will not generate current until its fields are excited, and they are supplied by current from *X Y*. Current is supplied to the motor field and resistance arms from a constant potential source *P*. The same results are obtained as were set forth in connection with Fig. 1. With the contact arms in position, shown in Fig. 2, the system is in balance; there being an equal amount of resistance in each arm, there will be no difference of potential between *X* and *Y*, and consequently no current will flow through the field *G*, and the dynamo will not generate. The hand wheel is turned so that the contact arm *S* is moved to the position shown by the dotted line, the balance of the system is disturbed, and current will flow in different quantities in *AC* and *BD*, causing a difference of potential between *X* and *Y*, exciting the fields *G* of the dynamo, which will send a current to the motor.

The motor revolves, carrying the contact arm *R* until this arm has moved over a value of resistance *B*, proportionate to that cut out of *A*, and then the system will again be in balance, there being no difference of potential between *X* and *Y*, no excitation of dynamo fields, and the dynamo stops sending current to the motor, which thus comes to rest.

To reverse the direction of rotation of the motor the contact arm *S* is moved in the opposite direction, the action being identical to that outlined above.

Various modifications of the above simple set are in operation; one set is as shown in Fig. 3. The motor *M-2*, exciter *E* (dynamo) set has been added. The motor drives the exciter at a constant speed. The exciter field has been excited by unbalancing the system, and this generates, feeding the main dynamo field. This avoids the use of heavy wires in the line and resistance arms for carrying the current required for the operation of the fields of the main dynamo, which is about 75 Kw., whereas the motor generator is about 1 Kw. The current required in the resistance arms is about 2 amperes by this method, or not sufficient to light 4 incandescent lamps.



ELECTRICAL STEERING GEAR, RUSSIAN CRUISER VARIAG.

Another arrangement is as shown in Fig. 4. The engine driving a dynamo also on the same shaft drives by means of clutch couplings the motor exciter set *E*. In this method the dynamo fields are supplied by the exciter of the motor exciter set, and the motor exciter fields are supplied by the varying potentials from *XY*, as in Fig. 3. The motor is driven as a dynamo and supplies the resistance arms and also the fields of the steering motor.

This method eliminates the dependence on an outside supply for its operation and makes it self-contained.

On the switchboard panel are fitted double throw switches, so that, in the event of trouble in engine or

dynamo, by throwing the switches the dynamos ordinarily in use for lighting the ship may be used. In this event the motor exciter set shaft can be disconnected from the dynamo by clutches, and after the switches have been thrown over the connections would be as shown in Fig. 3.

The steering motor having a rotary motion, all trouble from reciprocating parts is avoided, and, having only two ring oiled bearings, the attention required is reduced to a minimum.

The engine and dynamo being located in the dynamo room under the supervision of the attendant in charge of the other engines and dynamos, proper attention is given to the working machinery, and, in the event of trouble, the necessary attendance is at hand. The wiring does not occupy or heat the spaces as in case of steam pipes for the same work, and does not require the attention that joints in pipes do, or as large holes in the bulkheads. It is true that the size of steam pipes to the dynamo engines will have to be slightly increased, but this increase is almost imperceptible when compared with the long lengths required for an engine that is located in the steering gear compartment. It also leaves the steering compartment free from piping, so that the auxiliary hand gear can be operated in any event.

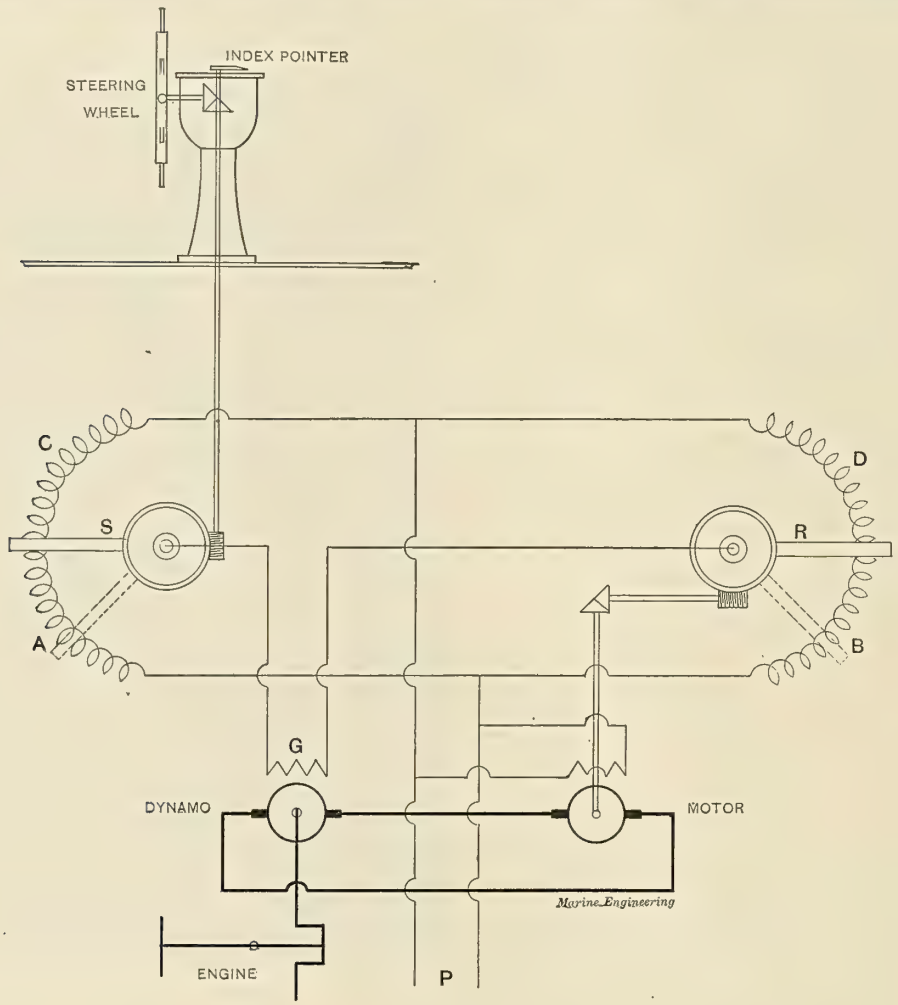


FIG. 2.

The question of actual efficiency can only be arrived at in comparing the two cases by a test of each individual case. The greatest loss in the steam gear would appear to be the loss due to the condensation in the steam and exhaust mains, plus the loss due to setting the engine valves at three-quarters or full stroke in order to clear the cylinder of water, and in the electrical system the power required to run the dynamo and engine empty, including the efficiency of the several machines used. In general, however, the fineness of control in handling the ship is greater in the electrical system than in the steam gear. This can more readily be appreciated in handling the ship during manœuvering in squadrons, on the sea during stormy weather, in approaching a dock, or navigating a tortuous channel.

The stretching of wire ropes, the excessive power required for shafting, and the liability to leakage in hydraulic gear for operating the admission valves of the steam engine are avoided, and with the proper protective devices installed on the wires conducting the current from the steering wheel near the steering station to the rudder, there is no apparent cause for any lengthy disability of the electrical system. In Fig. 5 is shown the variation in the power required for turning the rudder by the electrical system.

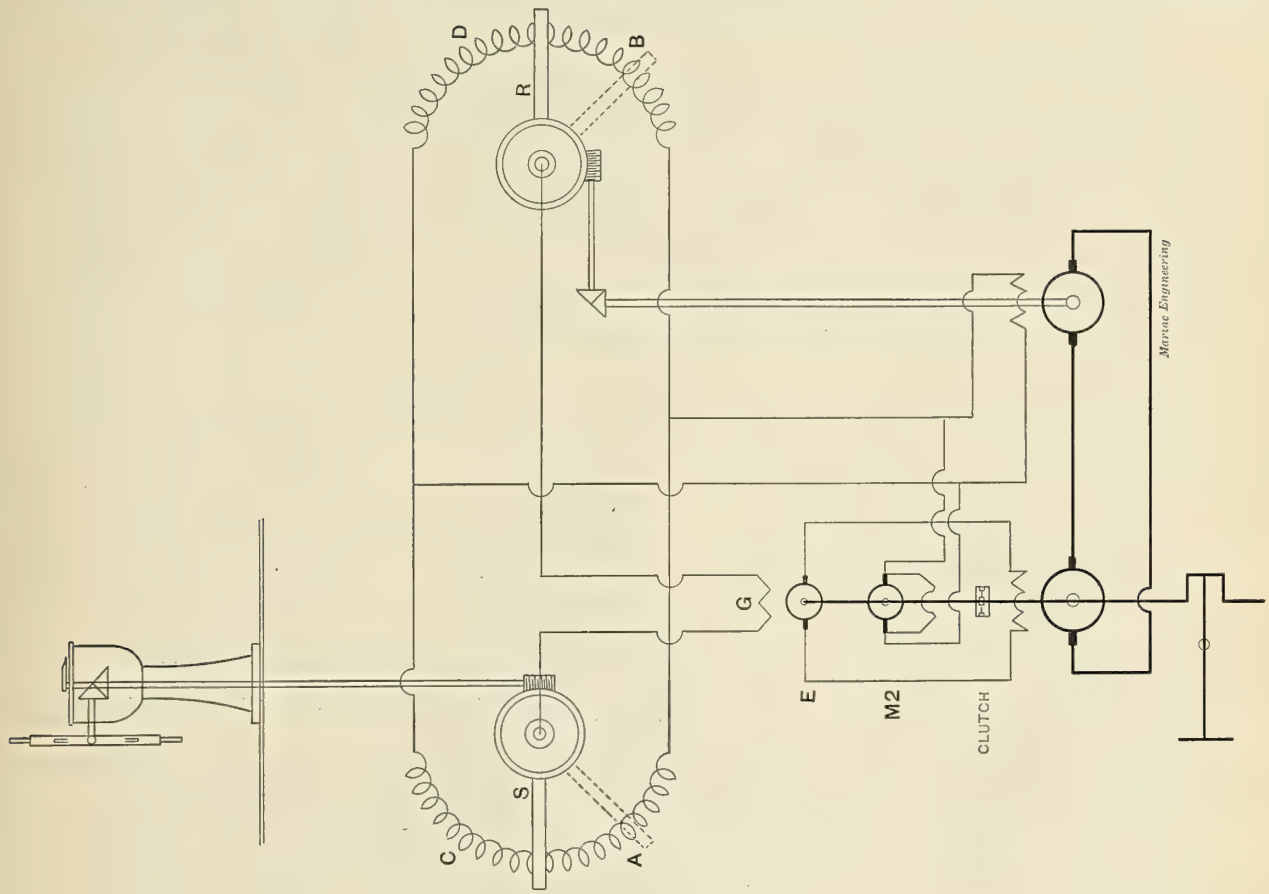

D
B
R
G
E
M2
CLUTCH
Marine Engineering
C
S
A

FIG. 4.

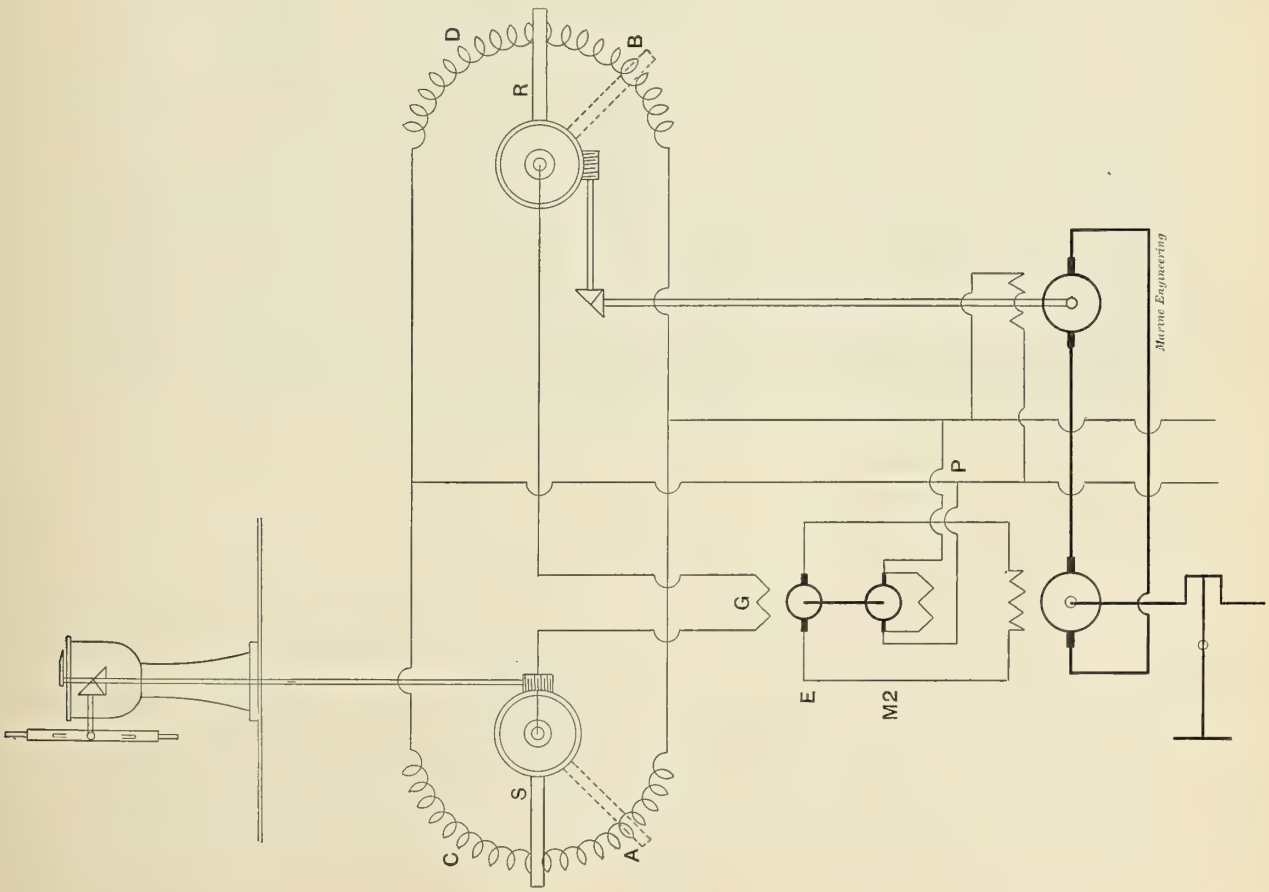

D
B
R
P
G
E
M2
Marine Engineering
C
S
A

FIG. 3.

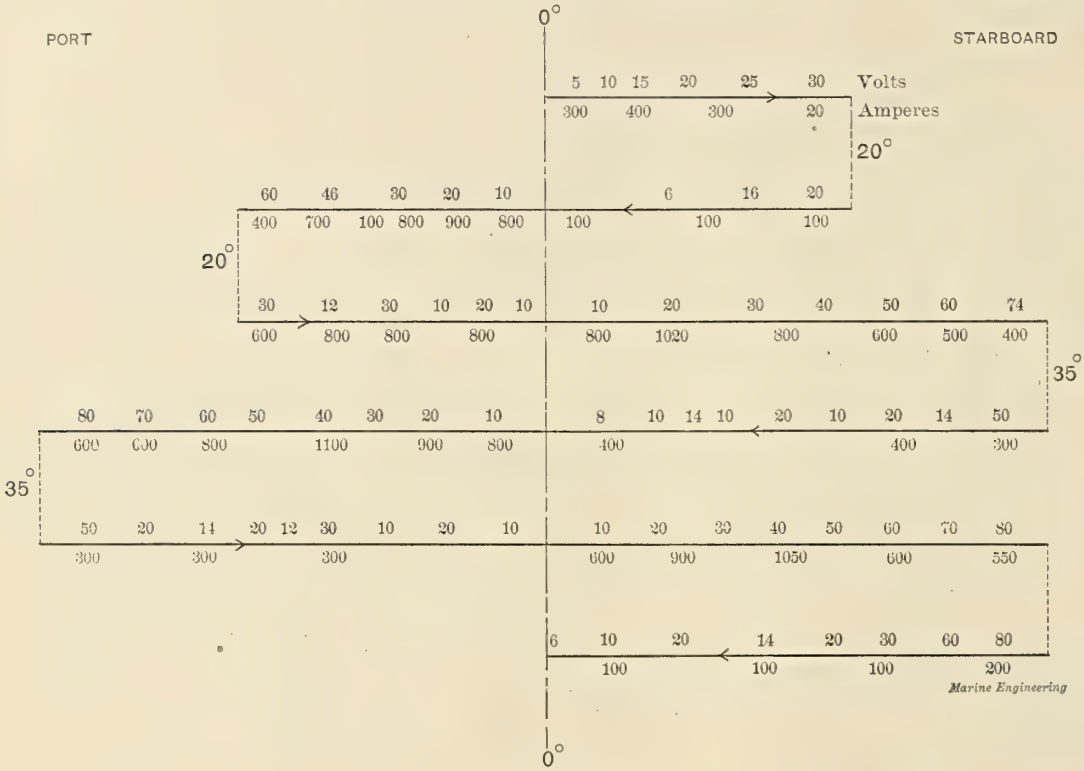

PORT
STARBOARD
0°
5 10 15 20 25 30 Volts
300 400 300 20 Amperes
20°
60 46 30 20 10 6 16 20
400 700 100 800 900 800 100 100 100
20°
30 12 30 10 20 10 10 20 30 40 50 60 74
600 800 800 800 800 1020 800 600 500 400
35°
80 70 60 50 40 30 20 10 8 10 14 10 20 10 20 14 50
600 600 800 1100 900 800 400 400 300
35°
50 20 14 20 12 30 10 20 10 10 20 30 40 50 60 70 80
300 300 300 600 900 1050 600 550
6 10 20 14 20 30 60 80
100 100 100 200
Marine Engineering
0°

FIG. 5.

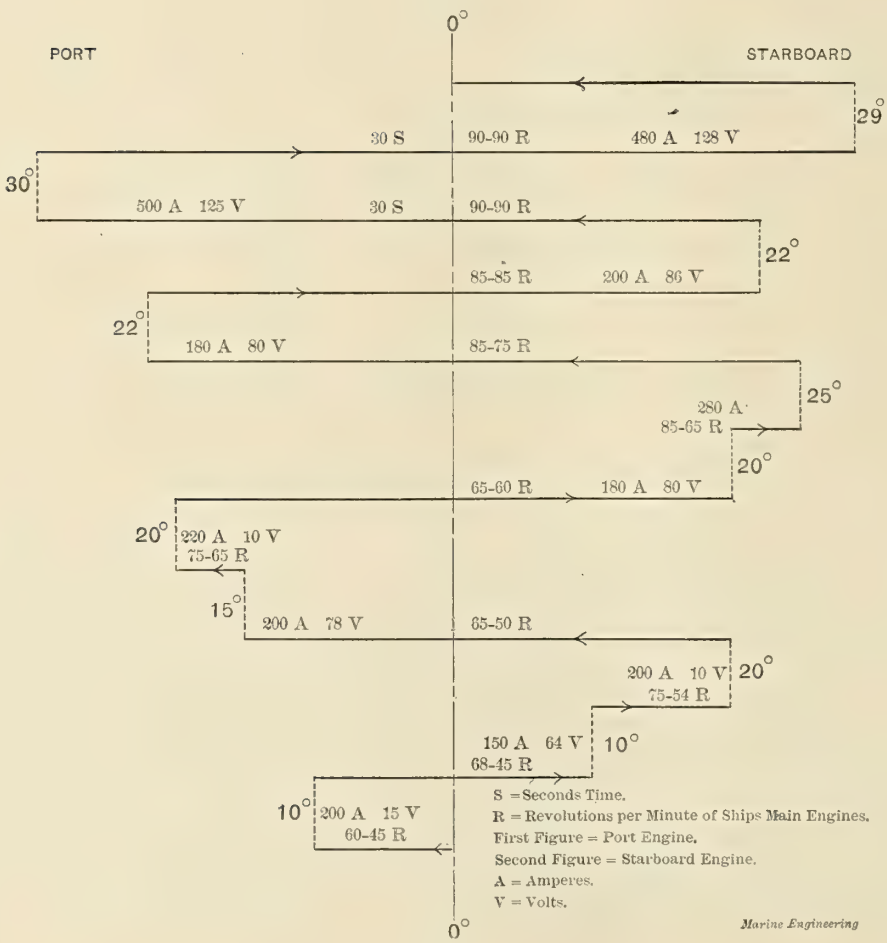

0°
PORT
STARBOARD
29°
30 S 90-90 R 480 A 128 V
30°
500 A 125 V 30 S 90-90 R
22°
85-85 R 200 A 86 V
22°
180 A 80 V 85-75 R
25°
280 A
85-65 R
20°
65-60 R 180 A 80 V
20°
220 A 10 V
75-65 R
15°
200 A 78 V 65-50 R
200 A 10 V 20°
75-54 R
150 A 64 V 10°
68-45 R
10°
200 A 15 V
60-45 R
S = Seconds Time.
R = Revolutions per Minute of Ships Main Engines.
First Figure = Port Engine.
Second Figure = Starboard Engine.
A = Amperes.
V = Volts.
Marine Engineering
0°

FIG. 6.

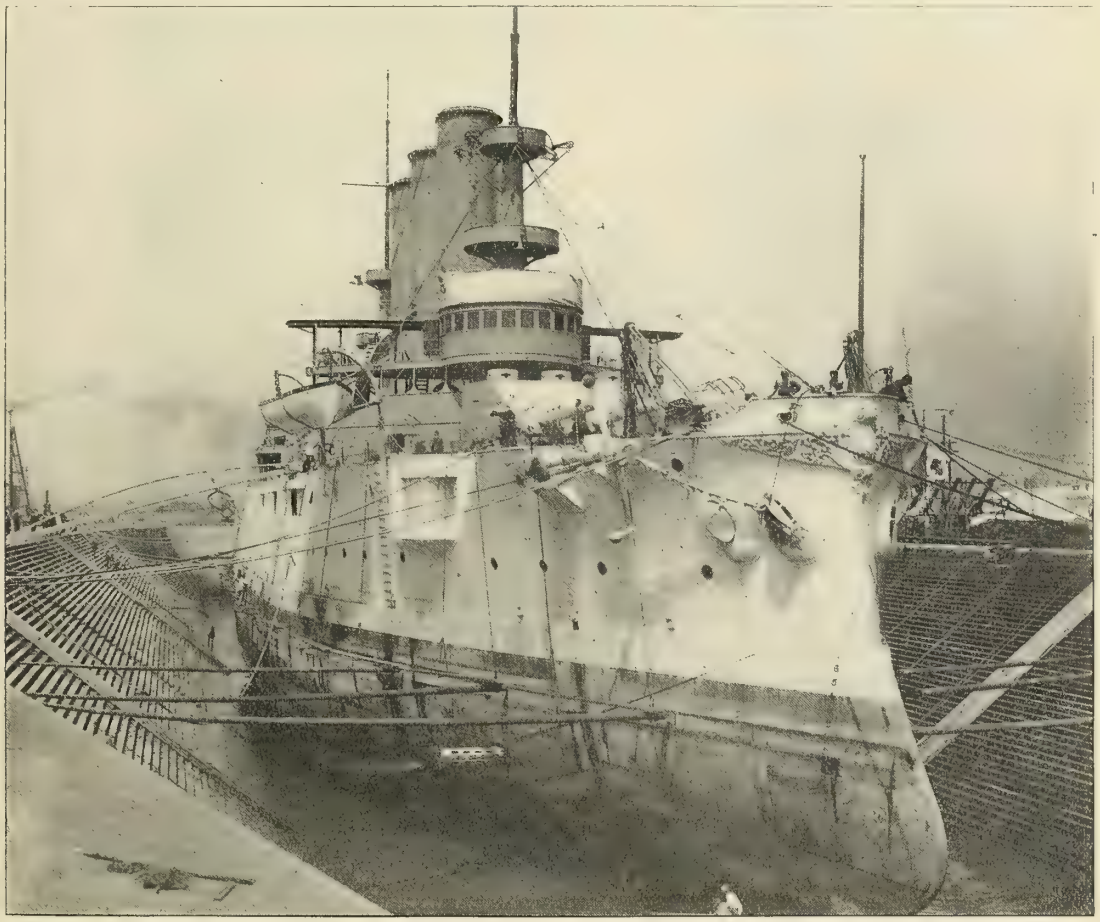
The figures were taken from a ship having a speed of nearly 18 knots, and a rudder of 197.8 square feet area, and a maximum helm angle of 35 degrees.

The figures on the upper side of the line are values in volts, and the figures on the lower side of the line are values in amperes. The figures show that the maximum power was required to put the rudder hard-over from a center position, and that little power was required to bring the rudder from hard-over to the center position. The rudder was first turned from center position to 20 degrees starboard, then back to center position to 20 degrees port, then to center to 35 degrees starboard, and so on.

The New Battleship Maine.

Herewith is presented a view of the new battleship *Maine,* taken before her official trial and while in dry-dock in the New York Navy Yard. The illustration is reproduced by courtesy of the *Brooklyn Daily Eagle.*

After being floated from the dock the ship proceeded to Boston and thence to the Cape Ann course. The contract required that a speed of 18 knots be maintained for four consecutive hours. The figures given out for the speed were 18.1 knots, although it is stated that tidal corrections will bring this figure up to 18.3 knots.



THE NEW U. S. BATTLESHIP MAINE IN DRY-DOCK.

In Fig. 6 is shown the power required under variable conditions of main engine revolutions.

The maximum power required in one particular case was about 112 H. P. to put the rudder from hard-over to hard-over, the ship having a speed of over 22 knots.

The instruments for measuring the volts and amperes, being permanent attachments on the switchboard, furnish a ready means of detecting, at stated periods, any inequalities of the power required for the gear. If the electrical system is used in conjunction with a steam gear having a helm angle indicator or a telemotor, the wires for these instruments can be included in the cable of small wires in use for the electrical system, as this cable is carried over approximately the same length as would be required for the above instruments.

The over-all length of the *Maine* is 388 feet, the extreme beam 72 feet 2 1-2 inches, and at the mean load draft of 23 feet 6 inches the displacement is 12,300 tons. The main battery consists of four 12-inch B.L.R. and sixteen 6-inch R.F. guns, and in the secondary battery are eight 6-pounders, six 1-pounders, two Colts, and two 3-inch R.F. field pieces. The 12-inch guns are mounted in two barbettes with armor of 12 inches maximum thickness, which are placed on turrets of 12-inch armor. This great vessel is propelled by two sets of triple-expansion engines, the diameters of the cylinders being 38.5, 59, and 92 inches and of 42-inch stroke, designed to indicate 16,000 horse power. Twenty-four Niclausse boilers supply the steam. The total grate surface is 1,353 sq. ft. and the total heating surface 58,104 sq. ft.

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TRUSTS and trade combinations represent one of the important industrial tendencies of the age. A further step in this direction along lines relative to marine construction has been recently announced in the formation of the United States Shipbuilding Company, including the following yards: Bethlehem Steel Company, South Bethlehem, Pa.; the Union Iron Works, San Francisco, Cal.; Bath Iron Works and Hyde Windlass Company, Bath, Me.; Eastern Shipbuilding Company, New London, Conn.; Harlan and Hollingsworth Company, Wilmington, Del.; Crescent Shipyard, Elizabeth, N. J.; Samuel L. Moore and Son Company, Elizabeth, N. J.; and the Canda Manufacturing Company, Carteret, N. J. At first thought it might seem difficult to understand the reason for a combination involving the yards mentioned, since it will in no wise furnish any exclusive control of operations on the Atlantic coast or elsewhere. Further consideration shows, however, that in this case no such exclusive control seems to be contemplated. In other words, the combination seems to have been formed without reference to the idea of a monopoly, regarding either territory or character of product. The obvious principle which the combination clearly embodies is that of including representative yards in different parts of the country suited either to general or to special classes of work, together with provision for supplying guns, armor, and ordnance supplies for naval contracts. The obvious plan of the combination will be to classify and standardize its output so far as may be possible, and then, by a suitable distribution of work, keep each yard busy on that type of construction which it is best fitted to carry out efficiently. With this thought in view it is clearly seen that the entire field of marine and naval construction is well covered in the various yards included, and that any order, no matter what, from a battleship to a torpedo boat or revenue cutter, or from a transatlantic liner to a tramp freighter or tugboat, or from a steam yacht to a houseboat, may be efficiently cared for in a yard well suited to the work in question. This seems to us the true function of the combination. It has in view increased efficiency of construction, but without monopoly or restriction of outside builders in the same field.

It cannot be too strongly realized that the secret of the highest success in any industrial plant involves the keeping, so far as possible, every wheel turning and every piece of productive equipment constantly at work and on that type of work which it can handle to the best advantage. This ideal can never be realized, of course, in a single yard where all classes of construction are handled. A long step toward such a condition may, however, be made if, in a central office, large numbers of orders may be classified and distributed with reference to the type of construction, so that in each yard the economy of specialization may be realized to the fullest practicable extent.

The formation of the United States Shipbuilding Company along these lines seems to be a wise move, and we may wish the combination the successful and prosperous career which its plan of work seems to deserve.

WE have previously in these columns referred to the questionable policy on the part of the Government of building battleships in the navy yards rather than by contract with private builders. The Navy Department, of course, has no choice in the matter and can only carry out the direction of Congress. In accordance, therefore, with the law authorizing the construc-

tion of the two battleships *Connecticut* and *Louisiana,* the Department is proceeding with the preparation of the building slip for the former at the New York Navy Yard. This work, consisting chiefly of pile driving, will be carried on through the fall and winter, and it is expected that the keel will be laid in the early spring.

The bids for the sister ship, the *Louisiana,* will be opened October 1, and it is understood that strict adherence to the Department's plans will be insisted on in order that the comparison between the two ships as to cost, workmanship, speed of construction, etc., may be as broad and accurate as possible. Usually, in bids for Government work and on Government plans, some variation in detail may be allowed in favor of modifications proposed by the builder. In this case, however, it is the intention to have the two ships identical in all respects, and the plans prepared by the Government will, therefore, be strictly adhered to.

This will serve as the basis for a most interesting comparison. It has long been accepted as a general proposition that work in a navy yard is more expensive, both in time and money, than by private contract, and the reasons have not been far to seek. Briefly, the more important are as follows: A shorter working day; a higher average price for labor per man-hour; the difficulty of introducing piecework, and the consequent reduction of the output per man-hour as compared with private yards; the difficulty, with such labor as must in any yard be paid by the hour, in keeping the output per man-hour for the navy yard laborer up to the point realized by the private builder. It is this last item, intangible in character and uncertain in amount, which has been largely blamed for the so-called inefficiency of navy-yard work. The cost of material and equipment generally in the two cases should be the same. The average prices paid for labor are matters of record, and the chief remaining item is this general charge of inefficiency made against the navy yard laborer. Whatever in amount this may be, it must be laid to the charge of the system in vogue in Government work, and must be either an inherent and necessary feature of such work, or accidental and unnecessary and therefore removable by improved methods of administration. The plan proposed in the building of these two battleships should throw some light on such questions, and should aid in making possible a more intelligent study of these problems of the administration of public works.

WE publish in another column an article on the influence of shallow water on the speed of ships; and while we cannot fully agree with all the points taken by the author, we are glad to give the article publicity, in the hope that it may stimulate others to contribute their experience along the same lines. The author claims that no vessel can go in shallow water faster than the natural wave of translation, and that the speed of such a wave is therefore an upper limit beyond which, no matter what the power may be, no vessel can be forced. In this connection we wish simply to draw attention to two points: First, the shallow water wave is not quite the same as the ideal wave of translation, which is only found normally in a canal or restricted channel, and it is somewhat uncertain to reason from one type to the other.

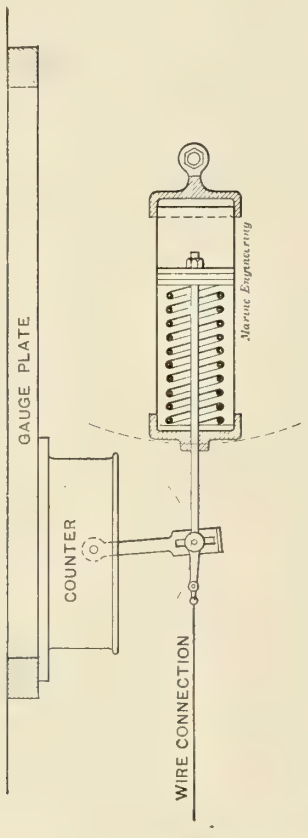
Second, the assumption that a ship cannot be propelled through shallow water at a speed faster than that given by the formula cited must, after all, be recognized as an assumption only. It is very sure that by external means, such as towing along a canal, a boat may be forced through shallow water at any speed quite independent of the depth of the water, but of course with an expenditure of power sufficient for the circumstances of the case. There seems to be no reason why, with the provision of sufficient power within the boat itself, similar results with the usual means of propulsion might not be reached. It is a fact, however, that at speeds perhaps approximately indicated by the formula proposed by Mr. Stevens, the resistance of boats in shallow water is likely to increase at an excessive rate; and while there is perhaps no reason for considering such speeds as an absolute limit, it is a fact that any excess in speed over some such limit must be paid for at so high a rate measured in horse power that even with excessive power the gain in speed is but slight, and there results, therefore, a practicable limit beyond which it is not economical to attempt to drive boats in shallow water. This is really the main conclusion of Mr. Stevens' article. The question as to where this speed comes in, and whether determined by the depth of water alone, as he proposes, or by the depth of water and the size of boat conjointly, is a question to be determined by experience, and to this end we shall welcome communications from those who may have had in their experience opportunities for observing and recording facts bearing upon these matters.

COMMUNICATIONS.

Troubles with Counter Gear.

Editor Marine Engineering:

Most engineers have, at some time or other, experienced difficulty with the gearing employed for operating engine revolution counters. Several years ago, while attached to a Cramp-built ship, we had all kinds of trouble with the counter gear. This revolution recorder was one of the ordinary circular-dial affairs, and in itself was all right. The gage-board to which it was secured was located on the forward engine room bulkhead, about at the height of the high-pressure cylinder and 10 feet outboard from the same on the starboard side. To transmit the reciprocating motion from the high-pressure crosshead to the counter lever necessi-



SPRING FOR TAKING UP LOST MOTION OF COUNTER GEAR.

tated a complex system of shafts, rods, bell cranks, and levers. Theoretically the gear was perfect and correctly proportioned, but practically it slapped and rattled, and wore down in the working parts to an extent that caused us considerable annoyance. On several occasions, by the breaking of small pins or the slipping of some of the connections, it gave out entirely.

By a combination of the engineering talent on board, a new gear was evolved which it was anticipated would obviate all of the annoying features of the old gear. This apparatus consisted of a cylinder, made of a piece of 2-inch brass pipe, which was so fitted as to oscillate on a stud, or stanchion, screwed into the fore-and-aft bulkhead close up to the gage plate. In this cylinder was a piston and a piston rod, the lower end of which was secured by a pin joint to the end of the counter lever. A spiral steel spring was fitted inside the cylinder between the piston and bottom head. The motion was imparted to the lever by means of a piece of 3-32-inch brass wire connecting to a lever on a fore-and-aft shaft which was rotated by means of a connection to the high-pressure crosshead of the engine. Brass chain and sheaves were, of course, fitted where the lead of the wire was changed. The operation was that, on the down stroke, the spiral spring was compressed by the piston, and on the opposite movement the spring forced the piston, and consequently the counter lever, up again. The wire was thus kept in tension at all times.

The accompanying rough sketch shows how the spring cylinder was arranged. For about a week after this gear was fitted no trouble was experienced with it. To all appearances it was working perfectly, but one day it suddenly gave out, much to the chagrin of those who had gotten the apparatus up. Upon examination, it was found that the constant work brought on the spring by 125 revolutions of the engine had been too much for it and it had broken. The chief engineer, after puzzling over the matter for some time, decided to try another experiment. This time he left the spring out entirely, threw away the lower head of the oscillating cylinder, and made a connection by a length of 3-8-inch brass pipe from the condenser to the top of the cylinder. The piston was packed, and in place of the spring we now had a vacuum of 25 inches for the wire to pull against. This arrangement was found to work perfectly, and it is in use now, having stood wear and tear for over two years without any derangements.

C. A. Chalkley.

A Patent Stern Tube.

Editor Marine Engineering:

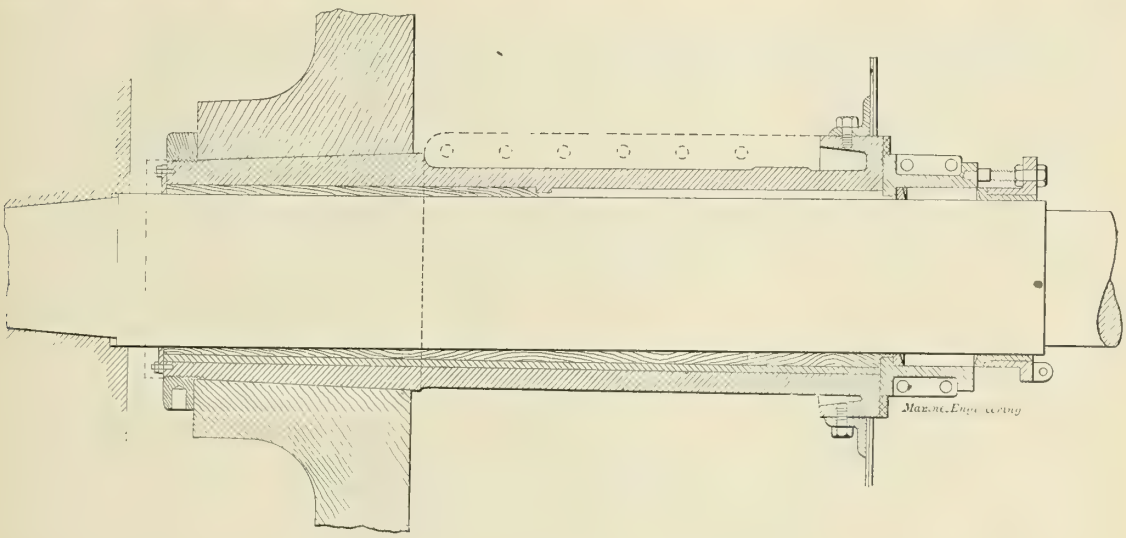
The stern tube is one of the most important parts of a ship, and a design which is conducive to good working and ease of overhauling is much to be desired. The ordinary form of stern tube, such as used in the merchant marine, is, of course, well known to all marine engineers, and a lengthy description is unnecessary. We may simply note that it consists essentially of a cast-iron tube containing a brass bush with dovetails, these dovetails holding strips of lignum vitæ as a bearing material. In some stern tubes the brass liner is dispensed with, the lignum vitæ strips being driven directly into the dovetails of the cast-iron tube, but this practice is to be condemned except in very small vessels.

In single-screw ships the distance between the rudder post and the stern-tube nut limits the length of the brass liner carrying the lignum vitæ strips, the brass liner being short enough so as to be readily withdrawn in case of necessary repairs. In ordinary stern tubes it is necessary to take off the propeller and draw the shaft in, in order that the lignum vitæ bearing strips may be renewed; and this proceeding entails a large expense, that is, if the shaft is drawn in solely for the purpose of removing the bearing material.

Keeping this in view, the problem presents itself as

follows: To design a stern tube which shall allow the packing wood to be removed and renewed without taking off the propeller and drawing in the tail shaft. A British marine engineer, well known on both sides of the Atlantic, has offered the stern tube shown here as a design intended to fulfill these conditions, and quite a number of them are in use, one of them having come under the personal observation of the writer.

Referring now to the accompanying drawing, the stern tube is made in separable halves and of cast iron. It will be noticed that the construction of the lower half differs from the upper one. The halves are securely bolted together, four of the bolts being fitted, and then the tube is passed into the hole in the stern frame and fastened by a nut on the after end in the usual manner. The shaft, when revolving, wears the bearing strips on the bottom, while the wear on the top wood is very slight. In this design the top lignum vitæ strips are therefore driven directly into the dovetails of the stern tube, and these strips are only 3 feet long. Of course, if these top pieces are to be renewed, it would be necessary to take off the wheel and draw in the shaft for several feet, but this contingency occurs but once in every eight or ten years.



A PATENT STERN TUBE, MADE IN HALVES.

Now, looking at the lower half, it will be seen that this contains a brass liner fitted with dovetails into which the lignum vitæ strips are driven. The center line of the bore of the bottom half has a downward inclination from aft to forward of 1-8 inch per foot. This increases the diameter of the bore from the center line of the shaft, and, while the brass liner is 5-8 inch thick throughout, to make up the deficiency the thickness of the wood in the dovetails is increased from 7-8 inch aft 1 5-8 inch forward. The stuffing box and gland are made in halves, so that they may be taken off the shaft entirely. As shown in the drawing, the shaft has two distinct stuffing boxes, the forward one leading into the shaft alley and the after one into the after peak.

Having now described the stern tube without going into those details of construction which may be readily seen on the drawing, it may be well to describe the method of removing the old wood and replacing with new.

Underneath the hub on the stern frame is a step bolted to the frames, and put on in such a manner as not to interfere with the propeller. This step is not shown on the drawing, but it serves for a support upon which a screwjack is placed. This jack lifts the shaft and thus releases the bottom brass liner of its load. The after-peak stuffing box and gland are then taken off, and the brass liner, with the lignum vitæ or the lignum vitæ strips alone, are drawn into the after peak and renewed without disturbing the propeller and the shaft.

One must admire the simplicity of the means by which the problem was solved, as well as the details of the design and the engineering skill with which the idea was carried out. In practice, however, it is found that other conditions enter and render difficult the carrying out of the repairs in the manner intended.

It was the fortune of the writer to have personal supervision of an attempt to carry out practically the idea embodied in this design of renewing the lignum vitæ strips without removing the wheel and drawing in the tail shaft; but although use was made of every facility of a well-equipped repair shipyard, it was not found practicable to carry out the intentions of the designer.

The jack was put under the stern shaft and lifted it against the top wood as far as it would go, and the shaft was also lifted by means of a tackle in the shaft alley. The stuffing box and gland were taken off, but the wood and the liner could not be started, and at last the old method of taking off the wheel and drawing in the shaft was resorted to.

The reasons why the wood would not come out are presumably many, and some may be mentioned. The shaft is flexible and wears more at the after end of the stern tube than at the forward end. The ship itself is flexible, and when in dry-dock assumes a different shape than it does while floating, thus binding the shaft when the ship is in dry-dock. Still other reasons might be found for the trouble met with in this case. This is the only example of a ship having such a stern tube which

has come under my personal observation, and perhaps in other ships the idea has been more successful.

Even if this patent stern tube fails to carry out the inventor's idea of permitting the renewing of the bearing wood while the shaft is in place, yet the whole design is a marked improvement over the old practice of a one-piece stern tube with brass liner, and the cost of construction of the two is about the same.

J. P. Badenhausen.

Torpedo Boat Trial Trips.

Editor Marine Engineering:

The failure of the torpedo boats in the United States navy to make the original contract speed has received wide attention, and in the report of Lieutenant G. Kaemmerling on a contract trial of the torpedo boat *De Long* the keynote of the situation, I believe, appears to have been struck.

In each case the finished weight of the torpedo boats and destroyers has been in excess of the estimated weight by many tons, and it was found impossible to drive a vessel with this added displacement at the contract speed. The Navy Department, therefore, reduced the requirements to a maintained speed of 24 knots for one hour in the case of the torpedo boats, and 26 knots in the case of the destroyers.

These trials have been conducted with most of the equipment on board, and it is a question whether, in the case of the torpedo boats, this should not be left out altogether, as the theory of the torpedo boat is that it is to be operated from a base of supplies, either afloat or on shore, and that it is not to carry full supplies on board. Lieutenant Kaemmerling says: "A great deal of the requirements put upon torpedo boats to make them absolutely independent must eliminate what has generally been considered the first requirement of the torpedo boat—namely, speed. Should independent action be required for any boat removed from the base, such hardships as would ensue from the lack of heavy bathtubs, marble-slab wash basins, various subdivided officers' quarters, all fitted with wood trimmings, a heavy cooking range, and other heavy equipment in galley and elsewhere, could be dispensed with and without unbearable inconvenience under campaign conditions. To sum up, a torpedo boat should be constructed to operate *from* a base, and not be equipped similarly to a cruiser."

If it is necessary to put this heavy equipment on board, let the torpedo boat first have her trial run and her record of speed established without these unnecessary weights. Then this equipment could be added to make her comfortable for the officers on board in times of peace.

This is such an important topic to builders of torpedo boats that I feel it should be brought before the readers of Marine Engineering to receive general consideration.

J. W. M.

A Steamboat Fire Story on Mark Twain.

Editor Marine Engineering:

Some months ago you published a story regarding a "donkey" engine on a steamboat, in which some experience of Mark Twain as an "engineer" was given. Perhaps, therefore, your readers will be interested in another story on Mark Twain which is going the rounds.

St. Louis.

Clemens was attached as cub pilot to a steamboat which was bound up stream with a heavy cargo of cotton. At the officers' table the first day out from Natchez, Miss., the talk turned upon what to do in sudden emergencies, and especially in case of fire on a steamer loaded with cotton. Mark Twain, like most of the others, held to the notion that it was the pilot's duty to emulate the now famous Jim Bludso and "hold her nozzle to the bank till the last galoot's ashore."

Among those at the table was the assistant engineer, a young man whose experience of life had taught him to doubt the ability of human nature to carry out the projects of its more boastful moments. He went below at the same time that Mark Twain went aloft, but the two continued to think of the conversation just closed.

The pilot house and engine room of a steamboat are connected, not only with bells for signaling, but with a speaking tube. The mouth of the tube at the upper end is but little larger than the human mouth, but in the engine room it has the shape of a funnel as big as a half-bushel measure. While the assistant engineer was pondering the emergency question he was also wiping off a portion of the machinery with a bunch of cotton waste, and as he reached the mouth of the speaking tube it was the work of but a moment to touch a match to the inflammable material in his hand and thrust it far into the tube.

Mark Twain, alone in the pilot house and still pondering the dire things he had heard about the horrors of burning steamboats, was horrified to see smoke pouring from his end of the speaking tube. There was but one thought in his mind. The boat was on fire. Dropping the wheel, which spun around and around as it left his hand, he grasped the rope by which the big bell was sounded and began pulling like a sexton, at the same time raising his voice in a cry of "Fire! Fire! The boat's afire!" Here the officers of the boat and the passengers are said to have found him, after hurriedly ascertaining that the alarm was false, still valorously determined to "save the ship." The boat, relieved of the rudder's guidance, had in the meanwhile swung around in the current and dashed full speed on a sand bar, from which it required half a day to drag her. And Mark Twain, having lost his nerve, left the river.

Mississippi Cotton Steamer.

Editor Marine Engineering:

I am sending to you herewith a photograph which will be of great interest to those of your readers who have not had experience on the lower Mississippi river. The picture shows the steamboat *Kate Robbins,* which had on board 1,010 bales of cotton. The cotton is piled nine tiers high on the main deck, and there are several bales on the hurricane deck.

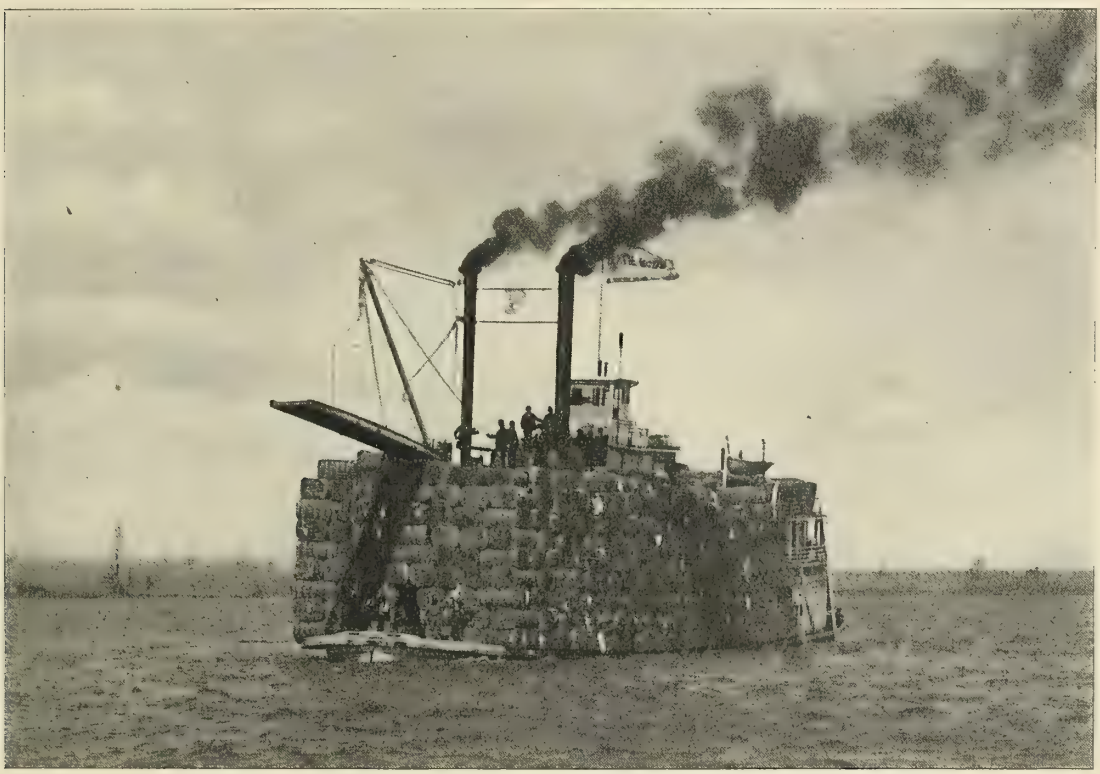
I remember away back in '73 the steamboat *Belle Lee* coming into the levee at New Orleans with cotton piled eleven tiers high, and later, in 1881, the big steamboat *Henry Frank* came down the Mississippi river to New Orleans with the cotton piled twelve tiers high. The number of bales was 9,226, making a somewhat smaller cargo than that of the *Kate Robbins.*

Cotton is put on board the boats on the Mississippi river under difficulties that would seem insurmountable to those engaged in the steamboat freighting business in the North. The *Kate Robbins* on this trip came from the Yazoo river to Vicksburg and picked up her cargo along the banks in bales numbering all the way from one to fifty at each landing. There are no facilities whatever at the so-called landings. The steamer is run into the bank head-on, and the landing stage, which, it will be observed, is hanging at the derrick on the boat, serves as the wharf. The colored roustabouts roll the cotton on board over this stage, and it is only by

employing a large number of men of the don't-care-a-continental style of negro that the cotton is handled at all, and when the river is very high or low the loading of cotton is a very difficult operation. Not infrequently the rain is coming down in torrents, and the roustabouts work in mud half way to their knees.

An important point in connection with cotton cargoes is that the danger of fires is very great. I notice that there is considerable agitation in New Orleans in regard to the danger of the use of fuel oil on board steam vessels, and that the insurance underwriters are leading the agitation. I do not consider fuel oil half as dangerous as cotton. On a cotton-laden boat the bales are piled all round, in every corner and in every place where there is room enough for them. Wood is burned very largely on the tributary river steamers, and great care has to be exercised, for, as you know, cotton is a good deal like gunpowder when a spark touches it.

George L. Norton.



MISSISSIPPI RIVER STEAMBOAT KATE ROBBINS WITH 1010 BALES OF COTTON ON BOARD.

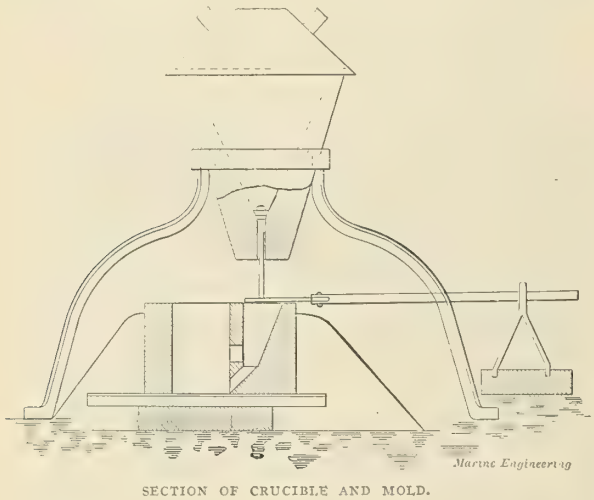
ENGINEERING SPECIALTIES.

Generating Intense Heat Through the Combustion of Aluminum.

Thermit is a metallic mixture discovered in its present state by Dr. Hans Goldschmidt. The compound consists in the main of oxides of metals and pulverized aluminum. The burning of the aluminum in the presence of these metal oxides, and by the oxygen in the metal oxide, generates a heat up to 5,400 degrees Fahrenheit (about 3,000 degrees Centigrade), and at the same time produces the metals in a very high state of purity. This mechanical reaction was known by Wöhler and other experimenters about fifty years ago, but it was left to Dr. Goldschmidt to bring the intense heat generated into practical use and to develop the different processes for the arts.

The Aluminum-Thermit processes can be summarized in, first, using the metal reduced out of the compound; secondly, using the heat generated only; and, third, a combination of both. The first part being purely metallurgical, by which free carbon, pure chromium, manganese, nickel, and other metals are produced, is not directly interesting to the shipbuilder and engineer. The process has been developed for butt welding of any profile or of any weldable material, so that angles, T-bars, and rails of any description are united to make practically one piece. The process is a very quick one, as it takes only about half a minute to weld a street-car rail of about 9 inches height. It makes the welding of angles, etc., possible in places where riveting is not practical. For heating bent stanchions, plates, etc., in order to straighten them, the quick and portable heat of the Thermit will be of great use in a shipyard. Light and heavy work have been done with economy and dispatch by this process, and shafts up to 10 inches in diameter have been successfully welded in one operation. The mending of heavy castings which have been cracked, or have not come out of the mold properly, is one of the features of Thermit. It also enables one to make, without any cupola, small castings, as the Thermit melts out about half its weight in metallic iron, the composition of which can be regulated to suit the case. In any emergency at sea it will prove of great help to the engineer for quick repair.

About the practical application, we might add that the Thermit is produced in special crucibles, which have a lining consisting in the main of magnesia. The Thermit is not inflammable by ordinary means, and a special igniting powder has to be placed upon it and ignited by a wind match in order to start the reaction. Without the igniting powder the Thermit will not burn, even if thrown in the fire or stirred with a red-hot iron. It will keep, if kept dry, indefinitely. There are two ways of emptying the crucible in which the reaction has been completed—one, by pouring it over the rim, and the other, by drawing it off from the bottom. In the first case the slag flows out before the iron, and in the second the iron comes first. As the slag cools far more rapidly than the iron, and deposits a thin layer on the object it touches, the first method of emptying the cru-



SECTION OF CRUCIBLE AND MOLD.

cible will be used in those cases where the heat only is to be used, and the adhering of the molten Thermit iron to the object is to be prevented. The second method is applied for joining pipes and tubes, for carrying gases or liquids at high pressure, for welding angle bars and other sections, etc., the result being a clean butt weld. The pipes and other sections can be welded in place, as the Thermit can be applied to them in any position. The weld is no more expensive than a flange for a similar repair.

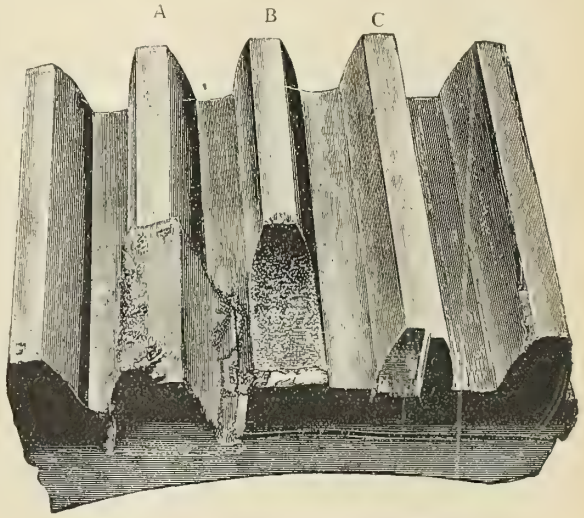
Tapping the Thermit iron first, the iron flows out at such a high temperature that it welds the surface of the metal it comes in contact with, and amalgamates with it. The slag which floats on top of the iron may either be retained in the crucible or else, in cases where it is desirable to hold the heat, can be applied to the weld. This metal has been largely used for welding street-car rails, casting at the same time the strengthening lug around the foot of the rails.

The repairing of faulty castings up to any size is done also by this latter method. In case of a crack, this has to be widened up to about 1-2 to 3-4 of an inch in order to let sufficient of the Thermit iron run in. The superheated metal will soften up the inner walls of the crack and unite with them so perfectly as to make one piece. By this method, many castings that would have to be discarded can be rendered sound and serviceable at a very slight expense, as it is possible to produce by the process an iron or steel of any composition that may be required. The repaired spot on the casting can be made, if necessary, of a structure and quality corresponding to the body. The casting on of broken teeth to gears has been done without even taking the gears out of position.

Where a mild steel casting is wanted in a hurry, it can be readily made by using Thermit with about 20 per cent. of small punchings or small pieces of metalized iron added. This is run into the mold in the usual way, no furnace or cupola being required.

The process is also used to superheat, as well as to render extremely fluid, both steel and cast iron, by adding between one and six per cent. of Thermit, according to requirements.

The Goldschmidt Aluminum-Thermic process includes also the use of titanium, which can be thoroughly incorporated in either steel or iron when in the molten state in the ladle. The titanium not only has the densening effect, but combines with the nitrogen which is contained, more or less, in every metal bath. Titanium makes a close-grained casting, without any bubbles, and castings of complicated design, such as cylinders, slide valves, etc., are especially improved by its use. Usually one-half to one per cent. of the Titanium Thermit is



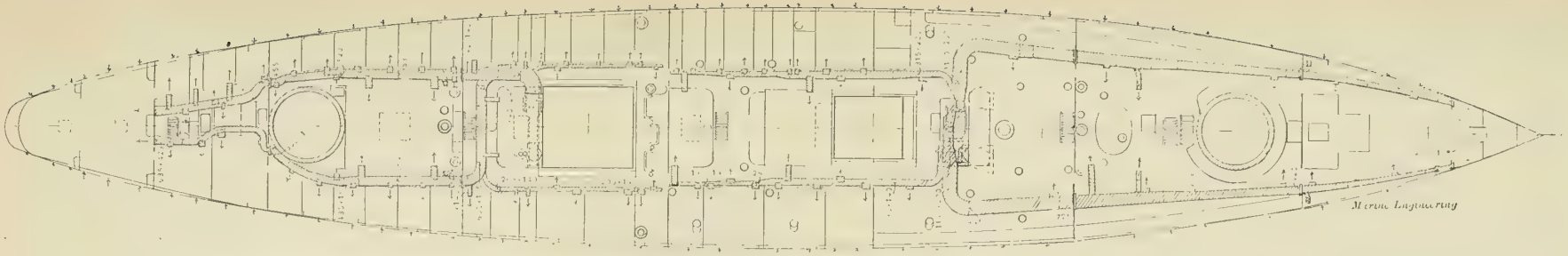
REPAIRING A GEAR WITH THERMIT IRON.

A shows a tooth mended but not machined.
B, broken tooth ready for pouring.
C, tooth repaired and machined.

added to cast iron; for steel castings, only one-quarter to one-half of one per cent. is necessary to insure a close-grained material. The larger the castings the better will be the results obtained, and the use of Titanium Thermit is specially recommended for charges of about 1,000 pounds and more.

It might be added that the slag, which consists of practically pure oxide of aluminum, is ground up and used as an abrasive material which is called "Corubin" and used for the same purpose as emery, carborundum, etc.

Any further information will be given by the Allgemeine Thermit Gesellschaft, Essen-Ruhr, Germany, or Mr. Clarence B. Schultz, the American representative of the company, 149 Broadway, New York city.



HEATING AND VENTILATING SYSTEM ON DUTCH CRUISER KONIGIN REGENTES—SINGLE FIGURES ARE THE BREADTHS OF DUCTS IN MILLIMETERS.

Konigin Regentes.

The development of the cruiser during the past few years has been very rapid. These war vessels are becoming more efficient and are better equipped, both for offensive and defensive work. It must be borne in mind that the best ship might soon become almost helpless in battle if it were designed and constructed without due regard to the ventilation of the different compartments which, with the advanced ideas of ship construction, become more numerous and independent. The powder magazines, store rooms, the fire room and coal bunkers must of necessity receive a good supply of pure fresh air, and this necessity increases with the high steam pressure which these modern war ships carry. While the advance made in cruisers has been very marked, the advance made in the heating and ventilating system of these fighting vessels has been even more notable.

For the purpose of illustrating and describing the heating and ventilating plant of a modern war ship, the Dutch Cruiser, H.M.S. *Konigin Regentes*, has been selected. It may be mentioned that the apparatus used to heat and ventilate this ship was furnished by the Buffalo Forge Company, of Buffalo, N. Y., through its London office, and the Ls. N. Alta and Company, of Amsterdam.

The entire heating and ventilating apparatus of this ship is situated on the berth deck and consists of two separate and distinct plants. The larger plant controls the midship and forward portions, while the after portion of the vessel is controlled by the smaller plant. The details of construction of these plants present some interesting features which it will be our purpose to bring out in the following paragraphs.

The forward apparatus, which is situated just aft of the fore-mast, consists of one 70-inch Buffalo Steel Plate exhaust fan, which is direct connected to a 5 horse-power General Electric Company motor, and 2,205 feet of heater, arranged in 5 sections, each section being placed in angle iron frames to prevent its slipping by rolling of the ship. Each steam coil section has 4 rows of staggered 1-inch pipe and is 8 inches wide, 4 feet long and 5 feet 10 inches high. Before leaving the works of the Buffalo Forge Company these coils were tested to 150 pounds per square inch hydrostatic pressure and are to operate under a maximum steam pressure of 120 pounds per square inch or so much less as may be necessary with warmer outside weather. The main supply to the steam receiver is 2 inches, while the drip connections are 1 inch in diameter. These heater sections are encased in a sheet steel heater case connecting the fan to the heaters.

The Buffalo Steel Plate fan has a capacity at the outlets of 10,700 cubic feet at 360 revolutions per minute. The fan is of the regular Buffalo full housing type, stiffened and braced with angle iron after the standard construction.

The ducts which convey the air to the different compartments of the ship are of special construction. They consist of an inner duct of 1-8-inch steel, around which is 1 inch of asbestos lagging, and covering this is another steel duct of quarter-inch metal. Where these ducts pass through water-tight bulkheads a steel gate is so arranged that the duct may be closed immediately, thus rendering the compartment absolutely water-tight, without destroying the heating and ventilating system of any other part of the ship.

The after apparatus, situated just forward of the main mast, consists of a 60-inch full housing Buffalo Steel Plate fan direct connected to a 4 x 3 1-2-inch double double-acting enclosed Buffalo engine. This engine runs at a speed of 400 revolutions per minute, at which speed the fan has a capacity of 6,100 cubic feet of air per minute delivered at the register outlets.

The heater consists of 5 sections, each similar to those of the other heater, and contains 1,365 feet. The main supply to the steam receiver is 1 1-2-inch. When outside conditions require, a pressure of 120 pounds per square inch may be applied to the heaters.

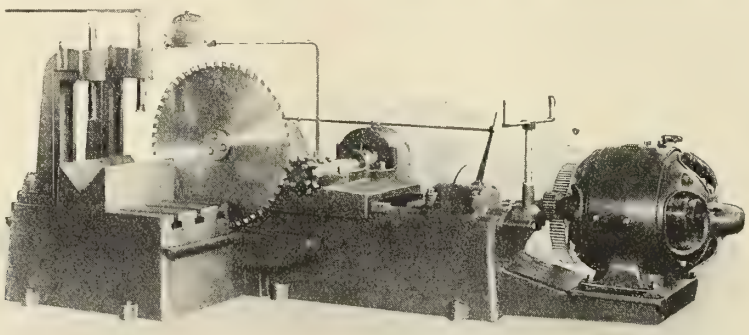
The engine works under any pressure from 120 pounds per square inch to 250 pounds per square inch. The cylinder of this engine was tested to a hydrostatic pressure of 290 pounds.

The heaters thus described are of ample capacity to heat the quantities of air, which the fans are guaranteed to handle and deliver through the 105 registers, to such a degree that the temperature of the ship can be maintained at 72 degrees Fahrenheit, with an outside temperature of 39 degrees Fahrenheit, when all the air is taken from the outside and when the heaters are supplied with a steam pressure of 120 pounds per square inch.

New Metal-Cutting Machines.

Two types of metal-cutting machines have recently been placed on the market by the Q and C Company, which embody many novel features and improvements. One is the Bryant saw, in which the saw blade is driven by a gear or sprocket wheel engaging with the teeth formed on the periphery of the blade, and the other is an arbor-driven saw, where the blade is driven by a central mandrel or arbor. Both types of these saws are made in two styles—cut-off saws and universal saws. In the cut-off type the blade travel is short and the machine is especially designed for cutting off round and square bars, structural shapes, etc. In the universal type the travel of the blade is longer, and the machine is fitted with an upper side table on which the work can be cut off for the entire length of the travel of the saw blade, while they are also arranged with V-blocks and lower tables for cutting bars and shapes.

The illustration herewith shows the motor-driven Bryant cut-off type of machine. When desired the machines are mounted on circular base which may be completely rotated by rack and pinion, this being a very desirable feature where there is not sufficient room for swinging a long beam. Lateral adjustment of side tables is furnished, if required, so that work may be adjusted for cutting after being secured.



A NEW METAL-CUTTING MACHINE, MOTOR-DRIVEN.

Special attention has been given to the arrangement of the tables on all machines, so that work can be placed most advantageously for cutting with a minimum distance of blade travel. The longer side tables are of sufficient length to enable beams, etc., to be properly supported when being cut off at any angle up to 45 degrees and to permit of steel castings within the capacity of the machine being secured to it.

All machines are fitted with the maker's type of frictional automatic feed, which is variable with the machine in motion. The feed is powerful in its action and gives a constant driving force throughout its entire range. The feed wheel is connected to the feed screw by a clutch operated by a lever, by moving which it is engaged or disengaged. In the universal saws the clutch also operates the power return movement with which these machines are fitted. A rod attached to this lever engaging with the carriage operates an automatic stop in both directions. When the clutch is disengaged the carriage can be moved in either direction by hand. The feed nut is solid, 6 inches in length, and bushed with bronze. It is bolted and tongued to the carriage, and can be readily moved without dismantling the machine.

The Bryant saw carriage is in two parts, the sprocket shaft bearing being cast in one piece with the worm-gear hood and is movable 2 1-2 inches toward the axis of the blade, allowing for a wear of 5 inches in its diameter. The sprocket is removable, and all sprockets on these saws are interchangeable and readily replaced. The arbor-driven saw carriage is of good design and exceedingly strong and rigid. All bearings are divided at right angles to the direction of the wear and are of extra large proportions. Both arbor gear and pinion are solid with the shaft, the pinion being hardened. The width of the face is large, and the liberal proportions employed have produced a very rigid and quiet-running machine. All gears in both types of machines are entirely enclosed, avoiding dust and the wear it entails when machines are not advantageously placed. The shears and tables are of strong and rigid design and are provided with oil troughs, so that all lubricant is returned to the central trough underneath the saw blade.

Further information and catalogue can be obtained from the Q & C Company, Western Union Building, Chicago, or 114 Liberty street, New York city.

Torsional Vibrations of Propeller Shafting.

In a recent article which is translated in the *American Society of Naval Engineers,* Mr. Herman Frahm, who is connected with Blohm and Voss, of Hamburg, gives the results of a most interesting series of experiments which he has been conducting. Marine engineers have for many years had to deal with a certain class of shaft fracture the cause of which could not be accounted for. The examination of the line of fracture resembles those caused by twisting action and have pointed toward the existence of considerable twisting moment, but no explanation of their origin has been given. Herr Frahm experiments were for the purpose of examining the extent to which vibrations of a propeller shaft actually occur and to deduce the influence which such vibrations may have upon the reduction of strength of the shafting.

In large steamers the distance between the engine and the propeller, as a rule, is a considerable one, and it is, therefore, obvious that the whole of the shafting.

in consequence of its length, must be regarded as a more or less elastic torsional spring, and not as an absolutely rigid body. This "spring" is kept twisted by the turning movement transmitted from the engine to the propeller. If the propelling power originated from some uniformly-turning machine, as an electric motor or steam turbine, the shafting and propeller would revolve uniformly, assuming the resistance of the propeller not to vary; but the case is very different when the turning force is not constant, but is subject to oscillations such as exist in reciprocating engines.

The following points were investigated: First, the twisting stresses in the shafting had to be found, both in regard to magnitude and variation; secondly, the corresponding variations of speed in the whole system, taking the engine and propeller each by itself, were ascertained.

The apparatus devised consisted of two zinc disks, one placed over the thrust shaft after coupling, the other placed on the propeller shaft coupling. Upon these disks platinum points were brought in contact at stated intervals of time, the points being given also a slightly longitudinal motion, so that the marks traced on the zinc would be spirals. When the points were in contact with the zinc an electric circuit was completed and the current slightly oxidizing the zinc traced a white mark. A timing mechanism made and broke the circuits at the two stations by lifting the platinum points simultaneously at a certain number of times each minute.

The comparison of the two zinc plates gives a complete torsional history of the length of shaft under observation, and from it were drawn curves representing the amount of twist at different intervals of time and the continual vibrations to which the shaft was subjected. Herr Frahm conducted experiments with the shafts of several steamers, and from the data derived from test pieces of the material from which the shafts were made he compared the maximum stresses due to vibrations with the mean stresses due to ordinarily-assumed working loads. The experiments show conclusively that the formulæ ordinarily used in determining the diameter of shafting do not take account of the full torsional stresses, and that shafts of larger diameter should be used. The experiments also point to the advisability of using hollow shafting, increasing the number of cylinders of the engine, or the substitution of the steam turbine as a motive power.

QUERIES AND ANSWERS.

Q. 101.—Suppose that the L. P. crank pin of a compound engine (marine pattern) broke, or, in other words, cracked, so that it would not be safe to run in that condition, what could be done to bring the ship into port, the engine having the air and feed pumps worked off the L. P.? Please let me know the best, safest, and quickest way to repair the same at sea. Hoping that you will oblige and give me a remedy, I remain,

J. E. B.

A.—In the issue of Marine Engineering for September, an answer to another break-down condition was by mistake published in connection with the above, which is therefore reprinted with discussion suited to the circumstances of the case.

The fact that the air and feed pumps are driven off the L. P. crosshead reduces the possible methods of procedure to the following:

(1) We might undertake a repair of the pin sufficiently thorough to carry a moderate load in the L. P. cylinder, and, assuming this possible, proceed with reduced power.

(2) We might undertake a repair of the pin sufficient to enable it to drive the crosshead and with it the pumps, but without allowing steam to enter the L. P. cylinder. In this case the H. P. exhaust must be led to the condenser directly by a connection made for the purpose, or through the L. P. valve chest, the valve having been removed and the ports blocked off.

(3) If not practicable to undertake a repair of the pin itself so as to operate the crosshead, we might still disconnect the connecting rod and swing it clear and then make some form of temporary coupling or connection between the two crank webs so as to transmit the power from the H. P. cylinder. In such case the pumps will be thrown out, the H. P. cylinder must be operated non-condensing, and the boilers must be fed by the auxiliary pump, which we may assume will be available for such duty.

Regarding the repair suggested in (1) and (2), its practicability will depend on the circumstances of the case. If, for example, the crank pin were hollow and a lathe were available, a small pin could be fitted inside the main pin, which might answer the purpose required. If the services of a portable electric motor were available, a hole might be drilled through a solid pin and then bored out to suitable size for repairing in the same way. If no such means were available it would be a hard matter to repair the pin so as to transmit power from the H. P. cylinder and at the same time operate the L. P. crosshead and pumps. If the operation of the pumps be dispensed with, as in (3), the connecting rod may be swung clear, and then, assuming sufficient clearance, the two L. P. crank webs may be bound or lashed together in such manner as to transmit the power developed by the H. P. cylinder. This may be operated non-condensing by breaking the exhaust connection to the L. P. and making a temporary exhaust lead to the deck.

Many details would depend on the special circumstances of the case. Thus, assuming the circulating pump independent, it might be considered worth while in the case of (3) to block the L. P. valve and allow the steam to exhaust through into the condenser, from which it could be drained out for feed pump supply. At the same time the vapor pressure will rise to atmospheric, of course, so that the engine will be operated with an atmospheric exhaust pressure; but the steam will be saved for feed water, and this may be a point of great importance.

Naturally, in a case of this kind, it is impossible to give any exact rules or code of directions, as so much must depend on the secondary circumstances. A break of this kind is always most serious, and without some adequate provision of tools and auxiliary machinery the difficulties of making any kind of a repair will be enormously increased.

Q. 104.—A certain boiler evaporates 20,000 pounds of water per hour from a feed-water temperature of 110 degrees Fah. into steam at 163 pounds gage pressure. If each pound of coal gives up 9,500 B. T. U., how many tons of coal would be used during a voyage of seven days? H. E.

A.—Taking, for round numbers, atmospheric pressure at 15 pounds, the absolute pressure will be 178, and from any standard steam table the temperature of the steam is found to be 371.9 degrees. For all ordinary engineering purposes it will be sufficiently accurate to take as the heat to be supplied per pound of feed water, up to the point of evaporation, the difference between this temperature and 110, the temperature of the incoming feed. This gives 261.9 heat units. Then the same tables give us 850.5 as the latent heat per pound. This must be supplied to complete the vaporization of the water into steam. Adding these, we have 1,112.4 heat units to be supplied per pound of feed water. If, then, we multiply 20,000 by 1,112.4, and this product by 168, the number of hours in seven days, we shall have the total number of heat units required. This divided by 9,500 will give the number of pounds of coal, and this divided by 2,240 will give the number of tons. Expressing this by a formula, we have:

$$\text{Tons} = \frac{20{,}000 \times 1112.4 \times 24 \times 7}{9500 \times 2240}$$

This figures out 175.6 tons.

Instead of the above method, we might have taken from the tables the total heat in one pound of steam above 32 degrees. This is 1,195.4. Then the heat in the feed water above 32 degrees is very closely 110 — 32, or 78. Taking this from 1,195.4, we have 1,117.4 as the heat to be supplied per pound of steam, instead of 1,112.4 as above. This would give 176.4 tons, and is a more accurate method, though the difference is not important for most engineering purposes.

Q. 105.—Diagrams taken from a simple slide-valve engine show a loop formed by the expansion curve extending below the back-pressure line. Another loop is formed by the admission line extending above the steam line. Is the trouble due to a wrong setting of the valve? How may it be remedied, if at all? State all you would do in case you decide that a change is required. E.

A.—The loop formed by the expansion curve indicates too much expansion, and hence presumably too early cut-off. The loop at admission indicates too much compression, and hence too early a closure of the exhaust valve. These, taken together, indicate that in general the valve events occur too early. The remedy for this is to decrease the angular advance of the eccentric, or, in other words, to turn it back toward the crank. This assumes, of course, that the steam and exhaust laps on the valve are somewhere near what they should be. If turning back the eccentric does not properly remedy matters, then the valve itself would require changing; but the details of such change could hardly be given without further information regarding the dimensions of the valve and ports.

Q. 107.—Will you kindly advise me through the columns of your magazine the horse power required to get the highest possible speed out of a yacht, say 75 feet long, using gasoline engines, and what would the speed approximately be for size of boat above mentioned, built for speed and for service along the Atlantic coast? What would be the minimum size of boat to get a speed of 20 miles an hour? Also, what speed approximately could be gotten out of a boat 75 feet long, said boat to use two 85-horse-power gasoline engines, said boat adapted for service along the coast? I would like you to suggest the beam measurement. W. W. W.

A.—The conditions which you propose—viz., the highest attainable speed and service along the Atlantic coast—can hardly be satisfactorily fulfilled in the same boat. If we define the boat to be for generally smooth-water conditions, but without sacrificing a reasonable degree of seaworthiness, then the problem may be worked out somewhat as follows:

Length	75 ft. 0 in.
Beam	8 ft. 0 in.
Mean draft	3 ft. 0 in.
Displacement	20 tons.

Then, for a speed of 20 miles per hour in such a boat, some 275 horse power would be required. In order to install machinery of this capacity, the most careful design throughout, as regards weight, would be required, though these figures are not impossible under the conditions of the best modern practice. It might be even possible, by special careful design, to raise the power somewhat, perhaps to 350 horse power, with an increase in speed to perhaps 22 miles. These conditions are extreme, however, and it must not be forgotten that gasoline engines of this capacity can hardly be said to be yet on the market. The operation of gasoline engines up to 25 horse power per cylinder may be considered as fairly within the limits of present practice in the largest sizes, but the building up of such engines to 200 or 300 horse power is beyond what can fairly be considered as within the limits of assured satisfactory operation with engines of this type. With two 85-horse-power engines, or 170 horse power, such a boat as above specified should make 17 to 18 miles per hour. In the dimensions of the boat above specified, seaworthiness and comfort have been sacrificed to speed. A much more satisfactory boat for most purposes could be made by adding to the beam and making the construction somewhat heavier, giving a boat as follows:

Length	75 ft. 0 in.
Beam	9 ft. 0 in.
Draft	3 ft. 6 in.
Displacement	27 tons.

Such a boat with 170 horse power should make some 16 miles per hour; with 275, some 18 1-2 or 19 might be expected; and with 350, something better than 20 might be expected. It is a question chiefly of the capacity of the builders of gasoline engines to construct machinery in such sizes which shall operate satisfactorily, and on a schedule of weight which shall not be heavier than in the best of present practice. With such machinery it will be relatively a simple matter to produce boats which shall realize the general line of performance indicated above. With increase of beam a still more seaworthy and comfortable craft could be made, but with corresponding decrease in speed.

Q. 108.—Will you please give me a rule for finding the amount of air entering a furnace from a blower fan 6 feet in diameter, 300 revolutions per minute, air duct 3 feet in diameter, air gage shows 1 inch pressure? M. N. D.

A.—For most purposes the following formula will be found sufficiently accurate:

$$V = 4{,}000\, A \sqrt{h}$$

where V is volume in cubic feet per minute, A is area of discharge opening in square feet, and h is draft pressure measured in inches of water. According to this

formula, the volume of air discharged in the case you mention would be: $V = 4{,}000 \times 7.07 \times 1 = 28{,}280$ cubic feet per minute. This assumes that you have a pressure of 1 inch over a discharge opening 3 feet in diameter. In any actual case the discharge will depend somewhat on the condition of the fires, and the draft pressure will also depend somewhat on where it is measured.

Q. 110.—Can you tell me of any eradicating composition that will remove water-proof drawing ink, such as Higgins', from paper without injury to the paper?

A.—We ask our readers who may know of such a composition to please advise us.

TECHNICAL PUBLICATIONS.

A Graphic Method for Solving Certain Questions in Arithmetic or Algebra. By George L. Vose. Van Nostrand Science Series, No. 16, second edition. Size 6 by 3 3-4 inches, pp. 42. Price 50 cents. D. Van Nostrand Company, New York.

Graphical processes provide, so to speak, a bird's-eye view of all relations entering into such problems as they are suited to, and thus make possible a mental grasp of the problem as a whole such as could in no other way be obtained. This feature of graphical processes is well developed and illustrated in the little book under present notice. The author has illustrated the applicability of graphical methods to a large variety of problems which have usually been considered as algebraical only, and has brought out clearly the comprehensive view which these methods give such problems as may be treated in this manner.

We cannot, perhaps, do better than illustrate one class of problems by a single example:

A starts from a town P and walks toward Q, 10 miles away. He starts at the rate of 3 miles per hour and walks 40 minutes, then rests 10 minutes, then walks 2 miles at the rate of 4 miles per hour, then turns around and runs backward 10 minutes at the rate of 6 miles per hour, and. after resting one hour, walks back to P at the rate of 3 1-2 miles per hour. In the meantime B started 1-2 hour after A and walked from Q toward P. He walked steadily at the rate of 3 1-2 miles per hour for 1 1-4 hour, and then at the rate of 2 1-2 miles per hour for 1-2 hour longer. After resting for 40 minutes he then ran forward for 6 minutes at the rate of 5 miles per hour. He then turned about and walked steadily back to Q at the rate of 3 miles per hour. Find the shortest distance which separated A and B, also when they were 6 miles apart, and the location of each man 3 hours after A started.

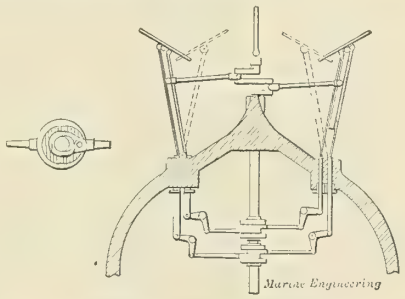
While the solution of such a problem can be reached by analytical means, yet it would prove puzzling to many, and in any event no such bird's-eye view of the relation between A and B as a whole could be obtained as by the graphical method. By such method the solution of the problem becomes as simple as one in direct multiplication or division. Such problems, of course, are not likely to be met with by engineers, but the principles involved may prove of the highest use, and we would recommend a study of these methods to all who are concerned with computations involving time, distance, speed, work performed, rate of work, rate of performance in general, etc.

SELECTED MARINE PATENTS.

705,866. ADJUSTABLE SCREW PROPELLER. EDWARD E. PUNZELT, NORWALK, CONN., ASSIGNOR TO HORACE E. DANN and OSCAR H. BANKS, NORWALK, CONN.

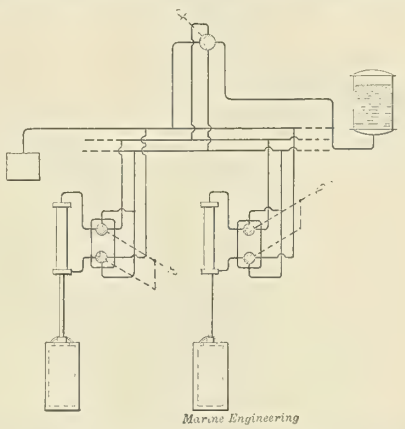
CLAIM.—1. An adjustable screw propeller comprising a hub having threaded bosses, blades having threaded shanks adapted to engage the bosses, set nuts upon the shanks adapted to engage the bosses to lock the blades when turned forward, and means for locking said shanks against movement in the bosses when the propeller is turned backward. Two claims.

706,198. VIBRATING PROPELLER. WILLIAM W. PHARES, NEW YORK, N. Y.



CLAIM 1.—A vibrating propeller comprising two arms hinged at opposite sides of the driving shaft, the cranks upon the driving shaft, the rods connecting the cranks with the arms to vibrate the same, the blades pivoted upon the ends of the arms, and means for tipping the blades when moved in opposite direction. Six claims.

706,471. MEANS FOR OPERATING BULKHEAD DOORS. PAUL HOPPE, BERLIN, GERMANY, ASSIGNOR TO NORDDEUTSCHER LLOYD, BREMEN, GERMANY.



CLAIM.—1. In an arrangement for closing and opening bulkhead doors from a central controlling station, the combination with hydraulic cylinders fitted to the doors, means for operating the doors according as pressure is admitted to either end of said cylinders, and a pressure accumulator, of a pair of pipes connecting the accumulator with the cylinders, a third pipe connecting the cylinders with an exhaust tank, independent pipes connecting said cylinders with said third pipe and controlled by local valves, and means for switching the pressure stored in the accumulator to either of the pair of pipes and connecting the other with the exhaust pipe. Four claims.

706,491. BOW-FACING OAR. RICHARD B. HANSON, BUFFALO, N. Y., ASSIGNOR TO J. HERBERT DIEHL, BUFFALO, N. Y.

Three claims.

706,561. SUBMARINE BOAT. JOHN P. HOLLAND, NEWARK, N. J.

Two claims.

706,578. MARINE ELECTRIC-LIGHT FIXTURE. GEO. L. MARTIN, NEW YORK, N. Y.

Three claims.

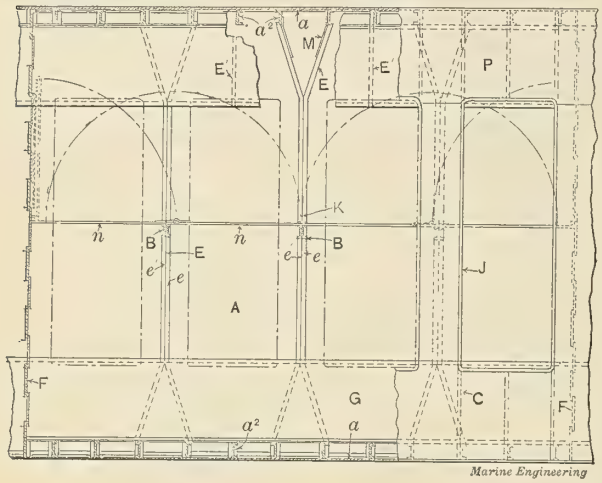
706,707. NIGHT LIFE BUOY. CONRAD C. A. E. WIESE, HAMBURG, GERMANY.

Six claims.

706,708. SHIP CONSTRUCTION. AUGUSTUS B. WOLVIN, DULUTH, MINN.

CLAIM.—4. In ship construction the combination of a hull having internal vertical side-frame members, stanchions rising from points above the center keelson and midway between the hatches, each stanchion consisting of two channel bars riveted together back to back, but having diverging upper ends, transverse spar-deck beams secured to the side-frame members and to the diverging upper ends of the stanchion members, transverse main-deck beams each consisting of a bar *e*, which lies in a transverse groove in the flanges of one of the stanchion members, and is riveted to the stanchion and has its ends bent out

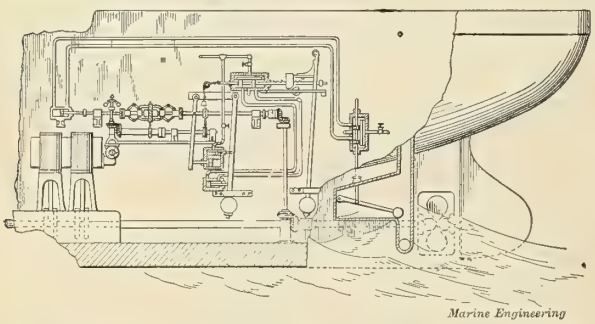
of line and secured to two of said side-frame members, and two bars *e e'* which are butted against the stanchions on opposite sides and extend therefrom toward the sides of the hull and have their ends bent out of line and secured to the side-frame



Marine Engineering

members, gusset plates lying on opposite sides of the stanchion and between the deck-beam members *e e'*, and secured to said deck-beam members, and angle irons fastened to said gusset plates and to the stanchions, substantially as described. Seven claims.

707,038. MARINE-ENGINE GOVERNOR. MARTIN F. VOLKMANN, SANTA MONICA, CAL.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CLAIM.—1. In connection with a marine engine and a propeller shaft driven thereby, a driving shaft operated from the engine, a governor for the steam valve of the engine and normally operated from said driving shaft, and means for speeding the governor upon the rise of the propeller in the water.

2. A marine-engine governor, comprising a governor having connection with the steam-controlling valve of the engine, a driving shaft operated from the engine, a driven shaft operated from the driving shaft, the said driven shaft consisting of two sections, one mounted to rotate on the other, a gear connection between the governor and said section mounted to rotate on the other section, a sprocket wheel loosely mounted on the driving shaft, a driving connection between said sprocket wheel and the last-named member of the driven shaft, clutch devices carried by the driving shaft and adapted for engagement with the sprocket wheel, and means for engaging the clutch devices with said sprocket wheel. Nine claims.

707,293. HYDRAULIC DREDGE. LINDON W. BATES, CHICAGO, ILL.

CLAIM.—1. In combination with a pontoon, a discharge pipe carried thereby; a shore discharge pipe; a flexible connection intermediate said pipes; a pivotal support for the shore discharge pipe, and means for raising and lowering said support. Six claims.

707,371. APPARATUS FOR REMOVING MATERIAL FROM BOATS, ETC. ALFRED M. ACKLIN, PITTSBURG, PA.

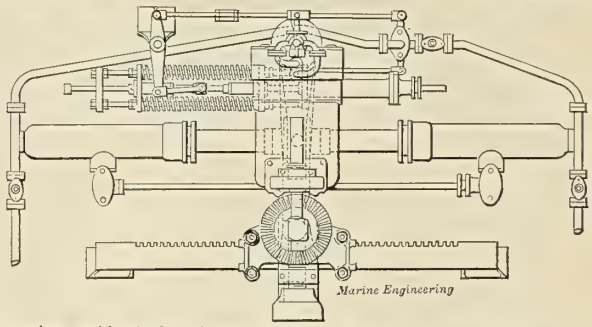
CLAIM.—1. The combination with a boat of a bucket adapted to be lowered and raised to and from the hold of said boat, a deflecting frame, and means connected to said frame for moving the same to tilt the bucket and move the same in a horizontal course to gather the material therein. Four claims.

707,411. MEANS FOR HOUSING PROPELLERS OF SHIPS. JAMES HAMILTON, GLASGOW, SCOTLAND.

CLAIM.—1. A ship having a propeller and shaft adapted to be moved longitudinally, and after portions of the ship in line with the propeller blades, said after portions being shaped to conform with the propeller blades. Three claims.

707,382. STEERING MACHINERY. ANDREW B. BROWN, EDINBURGH, SCOTLAND.

CLAIM.—1. Steering machinery comprising a rudder head, two tiller arms, a motor on one of the arms and hydraulic rams secured to the other arm, hydraulic cylinders for the rams, said motor arm having a slotted end, a carriage in said slotted end, a pinion and shaft carried by said carriage and a rack secured to the deck engaged by the pinion, a shaft actuated by the motor and movable radially on the tiller arm and gearing con-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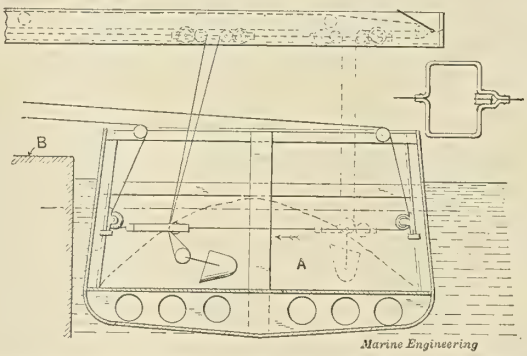
necting said shaft with the pinion shaft, substantially as described. Ten claims.

707,491. APPARATUS FOR REMOVING MATERIALS FROM BOATS, ETC. ALFRED M. ACKLIN, PITTSBURG, PA.

Nineteen claims.



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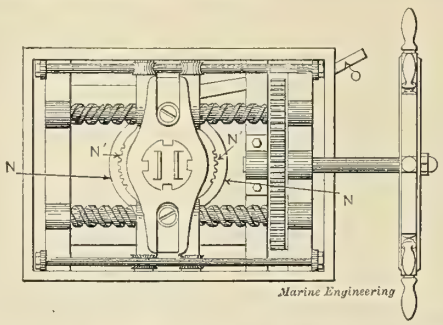
707,492. APPARATUS FOR REMOVING MATERIALS FROM BOATS, ETC. ALFRED M. ACKLIN, PITTSBURG, PA.

Seventeen claims.

707,600. ENDLESS PROPELLER. ADAM KUENTZ, COLBY, WIS.

CLAIM.—1. An endless carrier provided with folding paddles having extensions and a guard arranged parallel with and immediately below the upper portion of the said carrier for the aforementioned extensions of the paddles to travel upon to hold the paddles folded, substantially as and for the purpose set forth. Six claims.

707,607. SHIP'S STEERING APPARATUS. MAURICE E. LOWELL, BEVERLY, MASS.



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CLAIM.—1. In a ship's steering apparatus, a rudder post having secured to it a toothed ring *M*, in combination with pivoted levers, *N*, *N*, having toothed inner surfaces adapted to be interlocked with said toothed ring, a pivoted brake lever *O*, connected to the levers *N N*, as described, and means for adjusting and securing said brake lever in position. Two claims.

707,727. STEAM TURBINE. RICHARD SCHULZ, BERLIN, GERMANY.

Nine claims.

Trial of Swedish Destroyer.—The Swedish torpedo-boat destroyer *Mode*, built by Yarrow and Co., Limited, London, made an average of 32.428 knots speed during a three-hour run. The other means were: Steam pressure, 240 pounds; first receiver, 72 pounds; second receiver, 15 pounds; vacuum, 21 inches; air pressure, 1.5 inches; revolutions, 421.4.